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The Sixty-Third Meeting of the American Astronomical Society

By DEAN B. McLAUGHLIN

On invitation of Dr. Bobrovnikoff, the sixty-third meeting of the American Astronomical Society was held December 27-29, 1939, chiefly at Delaware, Ohio. It appeared on the records as a joint meeting with Section D of the American Association for Advancement of Science, but only one session was held in Columbus, where the A.A.A.S. fairly overran Ohio State University.

During Wednesday afternoon and evening, December 27, most of those attending the meeting arrived in the midst of a snow storm which threatened to be a real impediment to automobile travel. The new arrivals found tea awaiting them when they stamped the snow off and entered the warm and congenial atmosphere of Austin Hall. This was just the beginning; as one member remarked near the end of the meeting: "Every time we turned around there was something to eat." According to previous arrangement, members were "on their own" for Wednesday evening. A considerable number found their way to Bun's Restaurant and whiled away an hour or more at supper and in more or less earnest conversation.

Austin Hall, one of the dormitories on the Women's Campus of Ohio Wesleyan University, served as headquarters and hotel, and also as the place for the technical sessions. Most of the members and guests occupied rooms in Austin, and whiled away spare time looking over photograph albums which the usual occupants of the rooms had not taken home during the vacation. Housing arrangements were very efficiently handled by Miss Huntsberger (Gretchen to some of us), Dr. Bobrovnikoff's secretary. And at each mealtime she was on hand to smile at the guests as they entered the dining room,—and incidentally to see that nobody "crashed the gate."

In the first exchange of letters Dr. Bobrovnikoff wrote that the business manager of Ohio Wesleyan had promised not to try to make money on the meeting. He kept his word. Three nights' occupancy of rooms, plus two days' meals, with an extra breakfast at the end, cost seven dollars,—believe it or not.[1] Both quantity and quality belied the low cost. A member of a society which was meeting in Columbus (and paying Columbus prices), on hearing of this, threatened to leave his society and join ours.

[1] This included the Society dinner Friday evening!

But to return to the account of the meeting. At 8:30 Wednesday evening the Council met in solemn conclave in Austin Hall and did not finish wrestling with its problems until after eleven. In the meantime the members downstairs were doing what they usually do at the first gathering of a meeting: shaking hands all around, spinning yarns, talking shop, not to mention partaking of the ever-present tea. Nearly everybody went to bed about midnight. The writer was glad to find that the girl whose room he occupied had left an alarm clock out in plain sight.

On Thursday there were two sessions for papers in the study hall on the second floor. In the absence of President Aitken, Vice-President Fox occupied the chair and warned the speakers when their time was up. Some of them, by finishing ahead of time, proved that they did not need a warning. Others took all they had coming to them, and a few ran a little overtime, but on the whole the program progressed as well as the Secretary had dared to hope.

Just before the afternoon session there was a brief but significant business meeting. Without a dissenting voice the members voted to raise the dues from two to three dollars per year. The Treasurer, however, remarked gloomily that it would be a year before any benefits would be felt.

The afternoon session for papers was terminated at four o'clock, and was followed by addresses of cordial welcome delivered by Dr. H. J. Burgstahler, President of Ohio Wesleyan University, and by Dr. Alpheus Smith, Dean of the Graduate School of Ohio State University. Immediately thereafter, President and Mrs. Burgstahler held a reception for the Society in the parlor downstairs. And here, incidentally, the guests partook again of tea, cakes, and ice cream.

For about half of the guests the rest of the day was for relaxation. But dinner was finished a bit hurriedly by those who wished to go to Columbus to attend the Sigma Xi lecture by Dr. Kirtley Mather on "The Future of Man as an Inhabitant of the Earth." The bus, which was furnished by Perkins Observatory, left Austin Hall shortly after seven, loaded to capacity, and travelled at considerable speed over the rather slippery highway towards Columbus. Near the outer limits of the city a detour was made to avoid traffic. Apparently the driver overshot the mark, since the bus was presently in almost open country, and headed in the general direction of Pittsburgh. Passengers in the rear seats were betting two to one that the driver was lost. Those up front, in closer touch with the situation, were betting the same way ten to one.

The driver inquired at the first likely-looking place, which contained a long counter with a brass rail. He came out soon enough, without partaking of any refreshments, but some were worried as to the condition and competence of the person of whom he had asked directions. However, the bus and passengers arrived intact at Memorial Hall in time to see the august officers of Sigma Xi file in in their dress suits.

Dr. Mather was alternately optimistic and pessimistic about man's future. Extermination of life by changes of solar temperature or by a nova outburst of the sun were dismissed as too improbable to worry about. He covered, in brief compass, a number of aspects of the conservation of natural resources, and concluded with the general idea that anyway man's future was in the hands of God and of man himself.

The return to Delaware was more leisurely than the trip down, and the members of the expedition found tea awaiting them at Austin Hall. The remainder of the evening was spent chiefly in unastronomical pastimes. Van de Kamp and Huffer performed sporadically at the piano, and others engaged in parlor tricks, while Stebbins sat and talked with the ladies, and Fox "took in" a few unwary members in "heads I win, tails you lose" games.

In this connection, note the young man standing at attention at the left in the photograph. The case hanging from a shoulder strap does not contain a gas-mask for use during the meetings, but a candid camera (I mean *candid*). During the evening he shot a number of pictures by flash-bulb, and he has offered the Secretary a "cut" in his blackmail racket.[2]

Activities continued to a late hour, and the alarm clock proved useful again the next morning.

Right after breakfast another Council meeting was held. In the meantime most of the members drove or were taken by bus to the Perkins Observatory four miles south of Delaware, where the session for papers was to be held. At the conclusion of the Council meeting the Secretary and Dr. Bobrovnikoff taxied the Council to the Observatory. Meanwhile, those who had arrived earlier had been shown about the Observatory and had seen the 69-inch reflector and its brand-new spectrograph.

That morning's session was devoted chiefly to papers by the Perkins Observatory staff. A buffet luncheon followed, and the spacious library served temporarily as a dining room.

Immediately after luncheon it was time to start the twenty-mile trip to Columbus. Two of the writer's passengers obtained transportation otherwise. Dr. Smiley, in excusing himself, remarked: "Don't worry about me, McLaughlin, I have other transportation,—pick up a good-looking blonde in my place." Perhaps this shows what the astronomical mind thinks of in off moments, and perhaps not; but it seemed like sound advice and was followed a minute or so later.

The trip to the Ohio State campus in Columbus was accomplished in schedule time. Dr. Yowell, Vice-President of Section D, presided at the afternoon session, which began with an address on the subject: "Some Remarks on Gravity Clock Escapements," by Dr. R. Meldrum Stewart, retiring Vice-President of the Section. Several papers were presented after that, and the high point of the technical program was reached

[2] The Secretary is momentarily expecting to be blackmailed.

when Dr. E. C. Slipher exhibited photographs of Mars which he obtained at the Lamont-Hussey Observatory in South Africa. These showed conspicuous changes of form and size of some of the dark areas on the planet, when compared with the records of previous years, and a number of the "canals" were recorded quite clearly. The author derived some comfort from the similarity of the photographs to his drawings; he had feared that his own observations might merely show what happened when a spectroscopist tried to become a planetary observer in one summer.

During this technical session several of the wives who attended the meeting visited the A.A.A.S. exhibits in the Columbus Auditorium and then went to the Art Gallery. Later in the afternoon they were entertained at tea by the Women's Club of Ohio State. Whatever the activities engaged in, all members and guests were back in Delaware for the Society dinner that evening at Austin Hall.

Fox played and evidently enjoyed the rôle of toastmaster, and after-dinner speeches were made by Stebbins, Herget, and R. R. McMath. Stebbins' speech might be entitled "Astronomical Reminiscences," but he covered a good deal of territory outside that field. Among other things, he suggested that the girls whose rooms we occupied should have left their own photographs instead of those of their boy friends, and that the meeting should have been scheduled so that the girls would return just before we left, to allow us to meet them. (Professor Duncan please note, since the next meeting is to be at Wellesley.) But probably the best-remembered part of his speech will be the anecdote of the astronomer who dropped cigarette stubs down the tube of a reflector. Into the writer's mind there flashed some related incidents of his own experience. One evening last summer, during a sojourn at an eastern observatory, he showed the moon and planets to a lady visitor who smoked while she viewed them. In his ignorance of local custom, he was very meticulous about disposing of the cigarette ashes and stubs, only to be told by the janitor the next day that the regular observer simply littered the dome floor with them. Looking across the dining room, his eyes met those of that regular observer whose facial expression showed that there were two minds with a single thought. Added to this was the recollection of the ash-gathering power[3] of the Ann Arbor reflector and the chimney-like properties of the Cassegrain hole. This combination of thoughts may explain why the Secretary all but rolled under the table.

Herget also told anecdotes, in one of which the astrophysicists' propensity for writing a whole paper about a single spectrum line was played up, but the remark which took best was his apology that he "wasn't able to string a little story out as long as Fox or Stebbins could." Dr. McMath's speech showed that his motto probably is: "When shorter after-dinner speeches are made, McMath will make them."

[3] There are two power-plant chimneys about 300 yards southwest of the Michigan Observatory.

A telegram of New Year's greetings to our absent President was read, and Dr. R. M. Stewart presented a resolution of thanks to our hosts.

Immediately after this, the crowd adjourned to the study hall again, where four reels of solar films from the McMath-Hulbert Observatory were shown. An attempt to persuade the authors of some papers which had been left over from the regular session to present them at that time met with failure. Most of the authors requested that their papers be read by title. Smiley said he would present his paper privately before the three people who wanted to hear it, and he made good this promise.

Social gatherings continued for some time after this, until all were more or less exhausted and drifted off to their rooms. Some had already left for home earlier in the evening. In the morning, after a breakfast of buckwheat cakes and sausages, the rest took their departure. Later in the day the Secretary met a few of them inspecting the exhibits[4] in the Columbus Auditorium, but he then felt no more responsibility for them. The return trip to Ann Arbor was much like the journey down, with continuous threat of heavy snowfall, which materialized just as the destination was reached.

It is manifestly impossible to summarize here all the papers which were presented, but notice will be taken of a few of them. The program included fifty-six papers, of which several were read by title. As usual in recent years, the majority of them dealt with subjects pertaining to the sidereal system, with strong emphasis on spectroscopy and astrophysics. But the solar system was also represented by several significant papers, and advances in instrumental technique were recorded. One field of research which was not represented was the study of external galaxies.

In the field of instrumentation, two papers were especially noteworthy. In a paper which unfortunately was among those read by title, McCuskey and Scott described a photoelectric instrument for counting star images between assigned limits of brightness on photographs of star fields. This device should materially reduce the labor of obtaining the star-counts which are so important in the study of the structure of the galaxy. R. C. Williams and Hiltner described the construction of a self-recording microphotometer which draws an intensity curve directly, and eliminates the laborious calculation of intensities from the recorded tracings.

Two papers, by L. R. Wylie and by Brouwer, dealt with the orbit of Neptune and included the terms due to the perturbations by Pluto. Van Biesbroeck showed that two supposedly hyperbolic comets really had elliptical orbits, when the effect of planetary perturbations was taken into account.

"Space-reddening" of distant stars through absorption of their light of shorter wave-length by dark matter in the galaxy received attention in papers by Stebbins, Huffer, and Whitford; by Cuffey; and by O'Keefe.

[4] This narrowly escaped being written "among the exhibits."

Several papers made contributions to the interpretation of enigmatical peculiar spectra. Hynek and Whitt showed that Phi Persei is probably a true binary, and that the diffuse triplet lines of helium are formed mostly in the atmosphere of the secondary body of the pair. Baldwin presented an hypothesis to account for some of the puzzling phenomena of the spectrum of Gamma Cassiopeiae. He showed that changes of temperature and brightness of the star, and of the widths of its spectral lines, can be harmonized by postulating a change of size of the radiating surface of the star and a change of extent of its atmosphere, with corresponding variations of the speed of rotation, in accordance with the principle of conservation of angular momentum. New results on "forbidden" lines of highly ionized atoms of iron were discussed by Swings and Struve. The author, as usual, put in his ten cents' worth on the spectra of novae.

It is not possible to give individual credit for all the contributions to the study of binary stars and stellar spectroscopy. Suffice it to say that each represented some substantial advance in our knowledge of these subjects.

E. J. Moulton pointed out a possible modification of the close encounter theory of origin of the solar system. The rapidity of the encounter might result in so great a tidal lag at the time of closest approach that the elongation of the stars would be perpendicular to, instead of along, the line joining them; violent eruptions of matter from the stars toward one another might then occur at closest approach, due to great inequalities of internal pressure.

Mention has already been made of the excellent photographs of Mars which were taken by E. C. Slipher. In this connection notice must be taken also of the fine color photographs of Mars by E. P. Martz with the Tucson reflector. He exhibited them privately, but had no paper on the program.

In point of attendance the meeting was very successful for a winter one. The record shows 85 members of the Society and some 25 guests. In addition, the names of several outsiders unknown to the Secretary were recorded in the register at the Columbus session.

At this meeting the slate of nominations of candidates for office, to be elected next September, was approved, as follows:

For President	Joel Stebbins
Vice-President	H. R. Morgan
Secretary	D. B. McLaughlin
Treasurer	F. C. Jordan
Councilors	Charlotte Moore Sitterly
	J. A. Pearce
	H. M. Jeffers

The Council appointed H. R. Morgan, F. R. Moulton, and S. A. Mitchell as delegates of the Society to the Eighth American Science Congress which will meet in Washington in May, 1940. The Council also ap-

pointed A. D. Maxwell as Assistant Secretary *pro tem* until the author returns from California in July, 1940. Seven new members were elected to the Society.

It has already been noted that the next meeting will be held in September, 1940, at Wellesley College, on invitation of Professor John C. Duncan.

In conclusion, the author can not say that "any similarity to persons living or dead is purely coincidental," but it must be recorded here that any shafts which may seem to have been fired at individuals were purely in the spirit of fun, and none of them were intentionally barbed. Five years ago, the then Secretary insinuated that this author's accounts of meetings may not be strictly truthful.[5] In defense of these literary works the author can only say that when matters of scientific accuracy are not involved he has found that some stories can be improved upon in the telling, without crossing the boundary line between truth and falsehood.

ANN ARBOR, MICHIGAN, JANUARY 14, 1940.

[5] POPULAR ASTRONOMY, **43**, 78, 1935.

Fireball of March 19, 1939, over Nebraska

By O. C. COLLINS
(Assistant Professor of Astronomy, University of Nebraska)

On the night of Sunday, March 19, 1939, between 9:15 and 9:20 P.M. C.S.T., many people in the eastern part of Nebraska saw an unusually large and brilliant fireball which was remarkable not only for the length of its flight but also for the repeated outbursts of "sparks" at distant points far apart on its course and for the fact that no sound of explosion was heard.

The body appears to have crossed the Missouri River from Iowa to Nebraska at a height of about 75 miles a little north of Omaha, and to have travelled west 20° south for about 100 miles farther before vanishing near Hampton, Nebraska, while still some 35 miles high. When first sighted it may have been as far east as Dubuque, Iowa. Several reports state explicitly that, though sound from explosions was expected and listened for, no sound was heard.

When, two days after the event, reports and inquiries began to reach this observatory, the coöperation of the local newspapers was obtained in soliciting information from those who saw the phenomenon. All who responded were supplied by mail with diagrams on which they might record, on a uniform system, the azimuth and altitude of the object when first sighted and when last seen, together with a record of the time and estimate of the duration of the flight. Sixty-two reports were received of which six came from neighboring states. Four reports referred to an

entirely separate object seen at around 8:30 P.M. C.S.T., and following a course from west to east.

The projected line of flight of the 9:15 object was determined by reports from places where it passed "directly over head" or at a high angle to the north or south.

Estimates of the body's height are much less certain. This is due, at least in part, to the fact that few observers saw the flight over its entire extent. Also the fact that the body is described by some as breaking into several separate parts more than once during its flight makes it uncertain that any individual's report refers to the same position as another's.

The multiplicity of the "bursts" is attested by the following reports:

Nevada, Iowa (point N on map)

"It travelled by surges, that is it periodically slackened in speed, then pieces would break off and it would gain speed again."

Onawa, Iowa (point ON on map)

"What looked like a rocket went streaking across the sky. It would leave sparks, then not, then trail sparks again. When it disappeared it was like five sparks left which faded out."

Beatrice, Nebraska (point BE on map)

"Large bright yellow star . . . became slightly oblong, opened up and let out a large quantity of faintly green, red, and yellow stars, closed up—went on about a mile, opened up again, discharged a smaller shower of stars, closed up, went on perhaps ¼ mile, burned out and disappeared."

"Like gold yellowish headlight three or four feet in circumference. Seemed to die down then burst and threw off tail of stars. Then died down and appeared as a point of light going straight west."

Alexandria, Nebraska (point AL on map)

"It seemed to have lasted about a minute after it came to view from behind a building . . . it resembled a car light—then several small balls of fire falling directly below fell earthwards, reminding you of an airplane dropping flares."

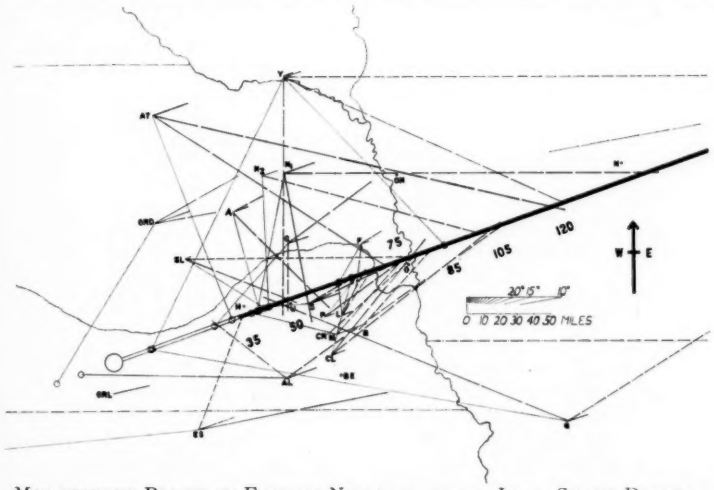
The apparently intermittent character of its visibility might account for the fact that the observers fall into three groups according as they indicate the point of explosion near Omaha (O, on map) or near Utica (U, on map), or near Hampton (H, on map).

Orleans, Nebraska (ORL on map)

"It did not seem to move across the sky—just came straight at me at about ¼ distance above the horizon like a thousand stars in one and went out as suddenly as it appeared after lasting several seconds."

Adopting the inclination of the line of flight thus indicated as 22½° we obtain for the height in miles at various points the numbers indicated along the projected path on the map. These heights may be compared with those indicated by the other observers by counting the number of "dashes" in the broken line running from each observer's position to the projected line of flight: each "dash" corresponds to 10 miles vertical increase of height. Thus the observer at Atkinson (AT, in the northwest corner of map) estimated the altitude when first seen as 20° and when last seen at 14°. The lengths of the dashes are accordingly 10 cot 20°

miles, 10 cot 14° miles on the scale of the map. [At the point Y (Yankton, South Dakota,) on the map, two sets of observations are represented, agreeing as to their first directions but differing as to the direction in which the body was last seen.] The unbroken line running from the observer's position to the projected line of flight is parallel to the line joining the ends of the first dashes and thus it is the level ground line in the plane-direction indicated. If the observations were exact and if the line of flight had no curvature this ground line would run through the point at which the line of flight meets the ground. Such ground lines from two positions should determine the ground point. How far this is from



MAP SHOWING PLACES IN EASTERN NEBRASKA AND IN IOWA, SOUTH DAKOTA, KANSAS, AND MISSOURI FROM WHICH THE FIREBALL WAS SEEN.

being the case in the present instance is easily seen. However, for each set of observations the indicated ground point on the projected line of flight has been shown by a small open circle. The larger open circle near Orleans, Nebraska, (ORL on map) represents the adopted ground point.

The grouping of the indicated ground points appears to correspond roughly to the three points of explosion—Omaha (O), Utica (U), and Hampton (H). This supports the suggestion that different portions of the body fell at different points along the line of flight. Further evidence to this effect is found in the different inclinations of the line of flight indicated by different groups of observers. From each point for which angles were reported a line is shown parallel to the projected line of flight. The other end of this line is collinear with ends of the first dashes and the length of this line accordingly shows the inclination of the line of flight as indicated by the observer at this point. The angular scale supplied permits these inclinations to be read from the map. It will

be noted that the reports from Atkinson (AT), Ord (Ord), Esbon (Es), Alexandria (AL), Martel (M), Norfolk (N), and Seward (S), support the inclination indicated by the observer at Orleans whereas a much higher inclination, 50° to 65°, is indicated by observers at Lincoln (L), Pleasant Dale (P), Fremont (F), and Elba (E).

Extracts from descriptions given in the various reports follow:

Omaha, (O)

"Appearing as a light on an airplane . . . kept getting larger and larger until when it burst it seemed much larger than a basketball . . . thought surely we would hear an explosion but there was not a sound. The sparks after it burst soon disappeared. They were multicolored."

Fremont, (F)

"I could see the center of it with the sparks coming from each side, and as it passed to the south of me it had a tail nearly two blocks long. . . . Several pieces of the tail seemed to drop straight down. . . . Meteor itself did not seem to be falling."

Lincoln, (L)

"Large ball of fire with sparks showering off and trailing behind." "Brilliant blue white ball with number of starry sparks trailing."

Bennett, (B)

"Colored stars came from it . . . could not see that the star itself had moved . . . looked like the tail of a kite."

Crete, (Cr)

"Yellow red glow changing to white—coming at us—streaks down in a spray of light."

Beatrice, (Be)

"At end of journey began bearing a tail of white sparks." "Seemed to explode into a shower of red sparks."

Norfolk, (N)

"Similar to the falling of a star but much, much larger, leaving streaks of light much like fire after it. It seemed to meet the horizon."

Hampton, (H)

"Steady bright light ahead" . . . "Flaming mass with trail of small ignited bodies."

Albion, (A)

"Greenish blue—leaving behind a heavy stream of sparks."

Elba, (El)

"A very bright light about three-fourths the size of the sun as we see it."

Esbon, (Es)

"Broke into a long stream of fire."

Atkinson, (At)

"When first seen it had no tail but as it traveled it grew brighter and it appeared to form a tail similar to a sky rocket," "Seemed to explode . . . larger than a falling star and very much slower."

Individual estimates of the length of time during which the fireball was visible naturally vary widely according to how much of the flight was seen by the observer.

The duration reported from Atkinson (AT) is 15 sec., from Norfolk (N) 10 or 15 sec., from Esbon (ES) 25 sec. The two observers at

Yankton, South Dakota, (Y) give 15 sec. and 30 sec., which values are roughly proportional to the lengths of path seen by each. These estimates yield a velocity between 10 and 20 miles per second.

The report from Gallatin, Missouri, (G) gives one and one-half to two minutes, and the indicated first direction from that point meets the projected line of flight 700 miles from the vanishing point between Utica (U) and Hampton (H). As this gives a very much lower velocity it seems probable that the total visible flight was at least 700 miles long. This would indicate that visibility commenced when the body was about 300 miles above the earth's surface.

THE OBSERVATORY, UNIVERSITY OF NEBRASKA,
LINCOLN, NEBRASKA, JULY 12, 1939.

The Principles of Planetary Color Research

By WALTER H. HAAS

It was with a certain amount of hesitation that the author selected the title of this paper; for laying down the principles of a subject really implies a long and thorough study of that subject, and the author's color research in connection with the planets is only two and a half years old. It seemed, however, to the author that an exposition of the nature of this work and a clear statement of its fundamental principles might serve to stimulate active and valuable research. If this paper serves this object, it has achieved its goal. The author is basing his remarks upon more than 1500 color observations which he has made himself with three different telescopes, a 12.5-inch reflector, a 10-inch refractor, and a 6-inch reflector, and upon 100 more observations the making of which he has supervised. The principles which we shall evolve should not be regarded as final and may very possibly require revision later. But even though the initial effort to summarize a subject may be faulty, and inaccurate, and fail to state the true principles of that subject, the effort is of value as a starting-point for later work; and in that spirit this paper is written.

The remarkable progress of sidereal astronomy, and particularly of astrophysics, in recent years has had no corollary, unfortunately, in planetary study. The chief reason for this lagging has probably been the subjective nature of visual planetary observation and the inferiority (in general) of photographs to the *best* drawings. Without asserting that the study of the planetary surfaces is mathematical, or that a personal element must not be allowed for, we shall herein try to show that much work of value can still be done on the bodies of our own solar system. The fact of color changes in the maria of Mars is only slowly gaining general recognition. That color changes occur in the belts and zones of Jupiter is known to students of that planet. On the moon occur changes more striking than those on either of these two planets; and yet they have been studied only by a very few.

Such color research is of considerable significance for our understanding of the surface conditions of other worlds. The color changes in the maria of Mars certainly constitute an excellent argument for vegetation. Whether certain lunar changes are due merely to the constantly varying angle of incident sunlight or whether due to actual physical changes on the moon, as the late Professor William H. Pickering, who was dean of those observers who have studied these changes, asserted; no explanation of them can be complete unless it includes lunar color changes as part of its larger whole. Pickering ascribed some of these lunar colors to vegetation, as he also did on Mars. The varying colors in the belts of Jupiter, which are due to clouds and certainly not to vegetation, are worthy of further study. Colors seen in Saturn's rings when they are nearly edgewise may be a valuable supplement to other phenomena seen when the rings are edgewise in enabling us to deduce certain facts about the thickness, density, and constitution of the rings. It will be seen that color research is not an idle curiosity, but a valuable supplement to several aspects of planetary research.

We shall in this paper first indicate some of the difficulties of color research, then explain certain techniques that should be followed (culminating in what data should be recorded with every planetary color observation), and finally conclude with the underlying principles of the whole subject.

The difficulties, it must be confessed, are indeed numerous; they might at first appear to render hopeles any quest for objective truth. They certainly do prevent us from using those mathematical methods so successful in astrophysics. The chief difficulties are nine in number.

1. The colors are themselves slight and vague, often being almost neutral gray.
2. There are numerous subjective peculiarities and errors in interpreting colors; the same color is described differently by different observers.
3. Haze causes colors to seem to change from what they are in a clear sky, even when the colors remain exactly the same.
4. The use of different magnifications causes colors to seem to change. Tints prominent with a low power may not be seen at all with a high power.
5. The moon or the planet may be so bright that it is difficult to observe colored areas upon its surface.
6. A telescope may have color peculiarities of its own. Reflectors are more nearly achromatic than refractors.
7. Imperfections of atmosphere and telescope may produce false chromatic tinges, especially on the limb of the object observed.
8. There may be differences in color-judgment between the right and left eyes of the same observer.
9. The color-judgment of an observer may vary, not only irregularly over short periods but also progressively over long periods.

The slightness of the colors themselves is the chief reason that they are so little known and so little studied. A casual observer looking at the moon only now and then would not be likely to notice its colored areas, and even a painstaking observer, if his attention were being concentrated upon something else, might overlook them. The colored areas of the moon, with the exceptions of a few regions strongly colored at sunrise or sunset, do not deviate much from gray. "Greenish gray," "gray tinted

by brown," "purplish tints on a gray background,"—such are typical descriptions of lunar colors, if indeed the object is not recorded as "sensibly gray," inferring that any brighter colors are too vague to be observed. The majority of the Martian maria look gray under ordinary conditions of observing. If the object itself is very vague, contrasting but slightly with its background, as is true of certain lunar areas and most of the belts of Jupiter, the color is of necessity very difficult to perceive.

The subjective peculiarities of different eyes in planetary drawing is now well known, and the personal equation is even more important in judging colors. Some eyes are very insensitive to color, seeing only black, white, and gray; other eyes, if the term may be used, are "color-wild," seeing all sorts of fantastic hues. Most eyes have some peculiarity in judgment. It is well for the individual to attempt to discover his personal color-bias and to allow for it, but he can do this only by carefully comparing his work with that of others who are working on the same objects. The color of the maria of Mars at certain seasons has been variously described as "robin's egg blue," "greenish gray," "bluish gray," and "gray" by different observers. Again, the floor of the lunar crater Grimaldi has been called "very green" by Professor W. H. Pickering, "bluish" by Ed. Martz of Chicago, and "greenish gray" by the author. Let a number of observers observe the same object with the same telescope on the same night, and the first impression of anyone attempting to correlate results is one of confusion. We need not leave everyday experience to detect such differences in color-judgment, Ed. Martz has written to the author that the color of the cover of an astronomical magazine was differently described by different people. The difficult conditions usually prevalent for planetary work accentuate these subjective peculiarities.

That terrestrial haze changes the apparent color of an object may be verified by anyone who watches haze gather or who simply watches the moon sink into the horizon mists. Even a slight amount of haze may change colors in this fashion. Lunar greens may be changed to grays and even to brown. It is in general best to observe colors in a very clear sky. The dimming of an object as day approaches influences colors in the same way as haze. It is best to make color observations only more than an hour after sunset or more than an hour before sunrise. The limit should perhaps even be an hour and a half.

An object may also seem to change in color because of the use of different magnifications. With a high power, the colored area is larger and less bright; the color will consequently in general be slighter. A color can very easily be "magnified out of existence." The author himself likes low powers best for color work, 158× on a 10-inch refractor and 96× on a 6-inch reflector. On Jupiter and Mars he uses high enough powers to see the objects observed, a difficulty largely absent with the larger lunar craters. Some observers recommend very high powers for colors on Mars, as much as 500×—600×. Others prefer to use both a

higher power and a lower one. The choice of magnification depends largely on the individual observer and the area to be examined. When several observers are collaborating on a program, it might be well for them arbitrarily to fix upon certain magnifications for use in order to secure better conformity of results.

If the moon or planet being observed is so extremely bright that the eye is dazzled, not much accuracy can be expected in judging colors on its surface. This effect is especially noticeable on the full moon in a very clear sky. The difficulty will bother novices more than experienced observers, and the former will do well to observe their lunar colors at other phases than the full one. A very clear sky or a low magnification, things otherwise helpful in observing, increase this difficulty by making the surface of the moon or planet brighter. Color filters are helpful in another connection, but they also probably help overcome this obstacle by reducing the brightness of the object. A wedge of neutral-tinted glass would do the same.

For the suggestion that each telescope may have color peculiarities of its own, the author is again indebted to Ed. Martz, who has observed with a number of different telescopes of different apertures, both reflectors and refractors. The only way such telescope-colors can be eliminated is by the same observers using different telescopes on the same objects under conditions as nearly alike as possible.

The vivid chromatic tinges, particularly reds and greens, on the limb of the moon, which are especially prominent in poor seeing, are familiar to every observer. They arise in the atmosphere and in the optical system of the telescope. They need not deceive an experienced observer, for they affect colors only at the edge of the disc under observation and can probably be distinguished from true colors even there.

The author was rather surprised to find that his right eye was more sensitive to green than his left eye. All other conditions of observation were of course exactly the same. He would be glad to communicate with anyone else who has found a similar difference in the color-perceptions of his own two eyes.

That color-judgment varies irregularly can usually be seen by tabulating a sufficiently long series of observations of the same object. Some of the observations are obviously somewhat discordant; and the discordance may be independent of magnification, clearness of sky, or any other factor previously mentioned. Physical and psychological daily variations would appear to be involved. The author also strongly suspects progressive changes in color-judgment over long (relatively) periods of time. Unless several lunar objects became greener, an altogether unlikely assumption, the author's eye was appreciably more sensitive to green in 1937 than in 1936. A psychological influence might be involved; for the author had found by comparing his 1936 observations with those of others made of the same objects that his eye was insensitive to green, and he perhaps unconsciouly corrected for this deficiency. But

this is not an inevitable inference; for the author had also discovered that his eye was insensitive to certain types of planetary detail (such as bright spots in the zones of Jupiter), and such detail remained invisible in 1937. This progressive variation of color-judgment is especially troublesome in observations lasting several years, *e.g.*, a prolonged study of some lunar crater; if the observer's judgment of colors varies, how can any long-period changes he suspects be trusted? It is epecially unfortunate for Mars. In order to study Mars over all parts of its orbit, we must observe it at seven or eight different oppositions, separated by intervals of two years. The complete cycle of seasonal changes on Mars can be obtained only by this fifteen-year-long study. If the observer's color-judgment varies in these fifteen years, and if we do not know how it varies, it is obviously impossible to ascertain much about seasonal color changes on Mars, a subject of great interest. The extent and seriousness of such long-period variations in color-judgment ought to be investigated.

The difficulties we have just been enumerating are certainly serious ones, and it might at first seem that an objective determination of color-change was impossible because of the nature of the subject. We do not think that such a statement is correct. It is nevertheless imperative that we recognize the obstacles and devise some procedure to overcome them. The technique herein described the author has developed himself, although it is not original in all parts.

Because of the slightness of the colors and the physiological-psychological difficulties inevitably involved in interpreting them, it is very important to have some comparison area that may be considered neutral gray in color. Once we possess such an area, we refer the hues of regions examined to it and observe no longer merely colors but instead differences in color. Such areas we have on the moon in the large lunar maria, widely distributed over the moon's visible hemisphere. It has been the author's practice to consider these maria, except when they are less than three days from sunrise or sunset, neutral gray. Each lunar object examined can then be referred to some area near it, and its hue may be described as greener or browner than that of the comparison area. On Mars there is, unfortunately, no neutral-gray region. The only sufficiently easily visible region on the planet that could serve as such is the Martian maria, but these maria themselves vary in color. On Jupiter we again lack any satisfactory comparison area. The polar regions might be so utilized but not all eyes see them as perfectly gray; and, besides, they are not always easily visible. Some bright area of standard and constant color to which to compare the zones of Jupiter is also lacking. It might be well to use some external comparison area in observing Mars and Jupiter. A color scale from blue to red might well be of value (though the author doubts whether the tints seen are always simple spectral tints; they may vary from green and green-gray through greenish gray and gray tinged by green to simply gray). The rings of

Saturn, when they are being observed for color, can be compared to the ball of Saturn. When we are making color-studies of marks on Saturn itself, we encounter the same difficulties as on Mars and Jupiter.

Another important technique in these studies of color is the use of color filters. Their action depends upon the well-known fact of physics that light consists of various wave-lengths ranging from deep red (8000 angstrom units) to deep blue (4000 A). Let us now suppose a lunar area, emitting light of wave-length λ_a only, situated on a background emitting light of λ_b only. We shall also suppose that there exists a filter a′ which transmits light of λ_a only and another filter b′ which transmits light of λ_b only. With filter a′ object a would be seen bright, but background b would be invisible. With filter b′ background b would be seen, but object a would be invisible. In practice the problem is much more involved. The objects emit light of various wave-lengths, and the filters transmit light over a certain range. It is in general well to know the absorption of filters for various wave-lengths; this absorption can be plotted as a curve. Although it is possible to determine the color of an object by observing it with a number of filters, ranging from red to blue, and although this method is good for confirming suspected colors, the author thinks that it is in general better to observe *differences in color* than to attempt to interpret results from the varying brightness of an object with different filters, a thing sometimes difficult. The best kind of filters is the kind made of gelatin. Glass can also be used. The author himself has employed sunglasses of different colors and even cellophane in getting results.

It will be obvious from what has been said before, that it is well to use a constant magnification and the same telescope during a series of observations; doing so eliminates possible errors caused by varying one or the other of these two and simplifies a study of the results. The eyes should be used alternately in observing colors. If the telescope used is in an enclosed room, it is better to work in the dark than to have a bright light near the telescope. The clearness of the sky should be noted. The author records it as clear, slightly hazy, moderately hazy, or very hazy. Ed. Martz used a scale of numbers from one (very hazy) to five (very clear) in recording this item.

The following things should be recorded with each color-observation: Observer, date, object observed, time, magnification, clearness of sky, color filters, and color seen. *None of these things can be omitted without diminishing the value of the observation.* The following might be a typical color-observation:

FEBRUARY 8-9, 1938. JOHN SMITH

Object	Time	Magn.	Clearness of sky	Filters	Colors
Lunar Crater "X"	9:10	180	Clear	None	gray
	9:13	180	Clear	green glass	greenish gray
	9:15	180	Clear	blue glass	sensibly gray
	9:17	180&230	Slightly hazy	brown cellophane	brown spots

We have so far spoken only of visual work on colors, but photography can be used also. The camera cannot record the hues directly, but it has the important advantage over the eye of being impersonal. The method to be employed in a photographical investigation of colors is photographing with several different color filters. Results of interest may be secured in this way; for example, Ed. Martz found in 1937 that the Syrtis Major of Mars, when it was deep blue in color, was very dark when photographed with a red filter. Certainly photography could be used to advantage in investigations of color on the moon, Mars, and Jupiter.

We have now discussed the difficulties of color-observation and the procedure evolved to meet these difficulties and are now ready to state the principles of the subject. In venturing to state these principles, the author realizes that he has had only two and a half years of work on the subject and that these principles may have to be supplemented or revised later; but he gives his judgment as that of one who has made a special study of the subject. I accordingly give as the five principles of planetary color research:

1. Observing not colors but *differences of color.*
2. Making observations *continuous.*
3. Making observations *numerous.*
4. Having several observers judge the hue of the same object.
5. Analyzing results to detect changes in color.

We have already explained that colors are so difficult to observe that it is better to estimate the differences in hue between the colored regions and comparison areas than to attempt to determine the color directly. This point need not be elaborated further, but it is very important in color-observations.

Scattered observations are of slight value in this work; and for a program of color-observations to be of value, it is important that the observations be continuous. On Jupiter and Saturn observations should, as a rule, be made several days apart. This is also in general true in the case of Mars. Because of the period of rotation of Mars, if observations are made about the same hour each night, any particular mark on the planet's surface can be kept under view for only a week. It is, of course, important to view the mark again when it is once more presented five weeks later. On the moon this day-to-day continuity is not so important as another sort of continuity, namely, continuity the ideal of which would be observations about six hours apart. Since the moon's motion and cloudy weather prevent this ideal from being realized, it is necessary to observe the regions being examined in several different lunations. This principle of continuity of observations cannot be overemphasized in color-work.

A few scattered observations of hues in the zones of Jupiter or a week's work upon a lunar crater's tints may be interesting, but such results are of no real importance unless they can be compared with observations of the same object made by others. He who wants to carry on a really worthwhile study of the hues of the planets and moon must plan to observe regularly over a long period of time.

The difficulty of the observations and the almost inescapable errors apt to be present in any single observation make it desirable to observe each object often. In this manner errors peculiar to individual observations can usually be eliminated. When we are analyzing results to determine the cycle of color-variations, we like to have as many observations as possible. Certainly one ought to have at least twenty observations of a lunar area in order to determine its color, and it is better to have a good many more.

The purpose of having several observers study the hue of the same object is to eliminate subjective errors. One may detect peculiarities of his color-judgment in this manner and allow for them in planning future color-programs. It is certainly best to have colors confirmed by others whenever possible. Whenever several observers are working at the same station, they should make observations independently in order to avoid a psychological effect in their interpretations of color.

We finally must remember that the determination of color is only a step to our ultimate goal—a careful study of color-changes. The mere fact of certain areas being certain colors is of little real significance. The investigation of change in color, however, of the times at which these changes occur, and of their regularity or lack of it may enable us to deduce conclusions of great interest and importance concerning physical conditions on the surfaces of our neighbor worlds.

Mount Union College, Alliance, Ohio, October 9, 1937.

A Simple Foucault Pendulum

By FREEMAN D. MILLER

Numerous descriptions of improved methods of constructing the Foucault pendulum have been published in this and other journals, and ingenious schemes have been devised to insure that the pendulum shall swing as long, and with as little elliptical motion as possible. It is sometimes desirable, however, to be able to construct quickly, and with a minimum of shop-work, a simple pendulum that will demonstrate to a small group Foucault's famous proof of the rotation of the earth.

The writer recently came upon a few suggestions which are not in a published form accessible to most amateurs, and which proved so useful that it seemed worthwhile to make them available to others.

These suggestions were developed by Dasannacharya and Hejmadi who were studying the behavior of the Foucault pendulum as influenced by air resistance and other disturbing factors. They wished to make their pendulum as short as possible, and their success can be judged from the fact that they obtained satisfactory results with a cord only 40 inches long and a 5.5-ounce bob. Their work was done at the Benares Hindu University, India, and published in the *Philosophical Magazine and Journal of Science*, **23**, 65, 1937, and **25**, 601, 1938.

They found that braided cords were superior to unbraided varieties. For our pendulum we have used braided fishline successfully. The secret of a good pendulum, however, lies in attaching the cord at the top so that it is in no way squeezed or deformed. Any distortion of the circular cross-section of the cord will be fatal to the success of the experiment. They recommend that the cord be held firmly in a hole just its own diameter. In constructing our pendulum we placed two wood blocks in a vise, and drilled a hole of the proper size along the interface so that it grooved the two blocks equally. The cord was led through the hole, and the blocks were placed in a small vise fixed in inverted position on the ceiling. By setting the vise up gently, the cord was gripped snugly, but without deformation. The cord was carried out of the upper end of the hole and made fast to a peg on top of the blocks. Thus it was not necessary for the cord to be held tightly enough in the hole to take the strain of the bob without slipping out.

Before inserting the cord in the hole, Dasannacharya and Hejmadi recommend that one stiffen ". . . the portion of the string that is to go inside the jaws at the top by slightly gluing the portion and drying it well before fixing. The fixing [in the hole or jaws] requires to be gentle. The success of the experiment . . . consists in avoiding flattening or giving any kind of asymmetry to the string near about the position where the string hangs out of the jaws. The stiffened portion should never project outside of the jaws."

Their experiments show that if the initial swing of the pendulum is too great, it will depart from the normal Foucault behavior after a few minutes. Our pendulum is ten feet long with a 12-ounce bob, and we usually draw it back eighteen inches before release. At the end of twenty minutes the amplitude is still about a foot, and the deviation in the direction of motion amounts to half an inch at each end of the swing. This change in direction is made visible by fixing a bright light to the ceiling beside the point of suspension. The sharp shadow cast by the bob on the floor enables one to follow, or to trace out the path with ease, and a half-inch deviation is perfectly obvious.

Our bob was a rather rough lead sphere, with the cord wedged into a small hole to avoid projections. The pendulum is drawn back with a thread looped about the bob, and released by burning the thread in the usual manner.

SWASEY OBSERVATORY, DENISON UNIVERSITY,
GRANVILLE, OHIO, JANUARY 9, 1940.

A Method of Making Aspherical Surfaces of Revolution by Means of Spherical Surfaces Alone

By JAMES G. BAKER

In the grinding, polishing, and figuring of aspherical surfaces of revolution of the character of the Schmidt correcting plate, difficulty is always encountered in obtaining a smooth figure and clear polish over the entire surface of the lens. Schmidt, himself, overcame the difficulty by bending his correcting plate over a partially evacuated and properly designed support system, so that by putting a sphere of a certain radius on the free surface, he was enabled to obtain the correct variation in thickness of the correcting plate. Others have made Schmidt cameras with the aid of various kinds of flexible tools, templates, small polishing tools, zonal figuring, etc. In the following paragraphs the writer describes a method by which a correcting surface of smooth polish and necessary accuracy can be obtained.

Aspherical mathematical curves of revolution can be expanded about their vertices and axes of revolution in the form of power series with even terms. Figure 1 presents an exaggerated cross-sectional view of a typical aspherical curve, the Schmidt correcting surface for minimum chromatic aberration, as it should look when finished. The equations of the meridian sections of the two surfaces of the plate are, respectively,

$$x_1 = 0$$
$$x_2 = ay^2 + by^4 + \ldots$$

where

$$a = -\frac{3}{8(n-1)R^3}h^2 \qquad \text{and} \qquad b = \frac{1}{4(n-1)R^3};$$

n is the index of refraction of the correcting plate, h the radius of the correcting plate, and R is the radius of curvature of the spherical mirror of the Schmidt system. These equations can be combined to give the variation in thickness of the correcting plate. If Δ_0 is the central thickness, then the thickness Δ at height y above the axis becomes

$$\Delta = \Delta_0 + ay^2 + by^4 + \ldots .$$

Apart from requirements for minimum chromatic aberration of a correcting plate, the value of the coefficient a may be of considerable range of positive or negative curvatures of the second order or smaller.

The equation of the circular meridian section of a sphere in a power series expanded about the vertex is

$$x_s = a_s y^2 + b_s y^4 + \ldots = a_s y^2 + a_s^3 y^4 + \ldots$$

where $a_s = 1/2r_s$ and r_s is the radius of the sphere.

We wish to examine the supposition that the variation in thickness of

a Schmidt correcting plate, or similar surface, through 5th order accuracy, can be considered as the variation in thickness of a weak lens bounded by two spherical surfaces, so that we write

$$\Delta = xs_2 - xs_1 = \Delta_0 + ay^2 + by^4 = \Delta_0 + (as_2 - as_1)y^2 + (as_2^3 - as_1^3)y^4.$$

We see that

$$\begin{aligned} a &= as_2 - as_1 \\ b &= as_2^3 - as_1^3 \end{aligned}$$

Let

$$as_2 = \alpha as_1 .$$

Then

$$\begin{aligned} a &= (\alpha - 1)as_1 \\ b &= (\alpha^3 - 1)as_1^3 \end{aligned}$$

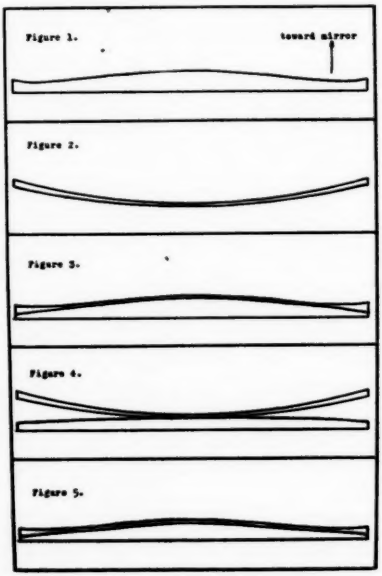
$$\frac{a^3}{b} = \frac{(\alpha - 1)^3}{\alpha^3 - 1} = \frac{(\alpha - 1)^2}{1 + \alpha + \alpha^2}$$

$$as_1 = \frac{1}{\alpha - 1}a \qquad as_2 = \frac{\alpha}{\alpha - 1}a$$

Thus we see that, if our assigned supposition is to hold, a must always be positive, since b is positive. This agreement in sign is in contradiction to the usual form of the Schmidt correcting plate, for which a is opposite in sign to b. It would be anticipated, of course, that the variation in thickness between two spheres will yield no inflection point. But by developing equations of the same type for a paraboloid and a sphere, an inflection point can be obtained. A careful examination of a correcting plate made by sphere and paraboloid shows that the amount of glass removed by aspherical figuring must be exactly the same as that removed from the usual Schmidt correcting plate by aspherical figuring and that consequently the use of a paraboloid must be abandoned.

If we make the choice of a dependent upon our choice of α, we find that, when the correcting plate is increased in negative power, a becomes real and different from zero. Consequently, we conclude that, were the correcting plate negative in the center instead of positive as in the usual form, the variation in thickness of the correcting plate would be equal to the variation in thickness between two spheres with specific radii, through 5th order accuracy. If α is set equal to zero, for example, one sphere vanishes into a flat surface, and a single spherical surface suffices for the correcting plate, terms of higher order than 5th being neglected. This plano-concave lens is strongly negative and has large chromatic aberrations. One might make an achromat with the same amount of negative spherical aberration retained in order to balance the positive spherical aberration of the mirror. The introduction of negative power, oddly enough, increases the speed of the Schmidt camera, but requires a larger mirror for unvignetted performance, and incurs the optical defect of astigmatism. Although for these reasons the combination should be avoided, a consideration of it throws more light on the intrinsic nature of the correcting plate.

An exaggerated meridian section of the correcting plate when $a = 1.2$ is shown in Figure 2. This form is undesirable from the standpoint of manufacture and optical performance. The question arises as to whether or not this bent form of correcting plate can be straightened out again mechanically. It must be noted here that the variation in thickness of the correcting plate does the work; the way in which the lens is bent is of only secondary importance. The thickness will remain practically unchanged by any form of small mechanical deformation. A second ques-



FIGURES 1-5

tion to be considered is whether or not the usual form of the correcting plate, which offers a minimum of chromatic aberration, can be obtained by adaptation of the above equations. The answer to both questions is, fortunately, yes.

Let the usual form of correcting plate be considered as made up of two lenses of the same kind of glass, as shown exaggerated in Figure 3. The interface is to be spherical. Let the surfaces be numbered in order from the left. To 5th order accuracy we may state that

$$\begin{aligned} x_1 &= 0 \\ x_2 &= \delta_1 + a_2y^2 + b_2y^4 \\ x_3 &= \delta_2 + a_3y^2 + b_3y^4 + \delta_1 \end{aligned}$$

Then

$$\begin{aligned} \Delta_1 &= x_2 - x_1 = \delta_1 + a_2y^2 + b_2y^4 \\ \Delta_2 &= x_3 - x_2 = \delta_2 + (a_3 - a_2)y^2 + (b_3 - b_2)y^4 \end{aligned}$$

and

$$\Delta = \Delta_1 + \Delta_2 = \delta_1 + \delta_2 + a_3 y^4 + b_3 y^6 = \Delta_0 + a_3 y^4 + b_3 y^6 ;$$

a_3 and b_3 are the usual Schmidt coefficients, that is,

$$a_3 = -\frac{3}{8(n-1)R^3} h^3 ; \qquad b_3 = \frac{1}{4(n-1)R^5} .$$

We specify that $a_1 = b_1 = 0$ and $b_2 = a_2^3$. The aspherical lens is now to be considered apart from the plano-convex lens. The variation in thickness of the aspherical lens is set equal to the variation in thickness between two spherical surfaces, s_1 and s_2, following the method described above. Then we may write

$$\begin{aligned} \Delta_2 &= \delta_2 + (a_3 - a_2) y^4 + (b_3 - b_2) y^6 \\ &= \delta_2 + (a_{s_2} - a_{s_1}) y^4 + (a_{s_2}^3 - a_{s_1}^3) y^6 \end{aligned}$$

or

$$\begin{aligned} a_3 - a_2 &= a_{s_2} - a_{s_1} = a' \\ b_3 - a_2^3 &= a_{s_2}^3 - a_{s_1}^3 = b' \end{aligned}$$

As above, we find that if

$$a_{s_2} = \alpha a_{s_1}$$

$$\frac{(a')^3}{b'} = \frac{(\alpha - 1)^3}{1 + \alpha + \alpha^2} \quad \text{and} \quad a_{s_1} = \frac{1}{\alpha - 1} a' = \frac{1}{2r_{s_1}}$$

$$a_{s_2} = \frac{\alpha}{\alpha - 1} a' = \frac{1}{2r_{s_2}}$$

$$a_2 = \frac{1}{2r_2}$$

Thus the entire correcting plate can be built up of spherical surfaces. The new feature involved is the production of the desired form through mechanical deformation.

The following procedure is suggested. Let a concave sphere of radius r_{s_1} be made in inexpensive glass by the glass-on-glass method and carried to a semi-polished stage. The figure should be spherical within two or three waves. A piece of vitaglass or crown or some glass suitable for a correcting plate is selected in slab form, of a thickness sufficient to be sturdy in use. This slab is to be fine-ground and polished, one face to a plane and the other to a convex spherical surface of radius r_2. Again the accuracy should be within two or three waves.

The next step is to procure a microscope cover glass or similar material of the size of the circular aperture of the Schmidt camera, and of such thinness that it will bend with ease to fit the prepared spherical surface of radius r_{s_1}. The No. 0 cover glass bends quite easily to a radius of 2 inches. No. 00 is too thin; No. 1 may prove most satisfactory. It is the radius of bending that is important and not the size of the piece. Cover glass may be obtained in large pieces from biological supply houses. Although usually cut into the small sizes required by microscopic work, the larger sheets can be obtained directly. Such glass is, of course, of good optical quality.

The cover glass is mounted firmly on the plane side of the completed plano-convex lens by means of some suitable cement, and is pitch polished in order to obtain a good, clear optical surface. The next step is to remove the cover glass from the lens and to mount it firmly, polished side inward, on this concave spherical surface of radius r_{s_1} by means of some suitable cement. The spherical surface is to be used solely as a template. The convex spherical tool should be used to press the cover glass against the spherical template, and clamped until the cement has hardened. A sheet of paper should be placed between the convex tool and the cover-glass to take up the slight lack of contact. When properly done, the contact between template and cover glass should be closed within a wave or so, and will be even better under the pressure of polishing. Fine-grinding the cover glass to a spherical surface of radius r_{s_2}, and bringing it to a fine optical polish are the next steps. When this surface is completed and accurate within a wave or two, the cover glass is to be removed from the template.

The cover glass is now mounted on the convex side of the plano-convex lens, so that the two outer convex surfaces are together. As the bending required is several times smaller than that required by the template, there is little likelihood of breaking the cover glass. The thick and the thin lenses are cemented together with Canada balsam to reduce the number of glass-air surfaces. In Figure 4 is shown the form of the correcting plate before cementing, and in Figure 5 the completed correcting plate. The correcting plate should now be mounted in a good cell, that will prevent the lenses from parting, should the Canada balsam fail to hold. This cemented lens constitutes the finished correcting plate, and has the same form as that given by the correct equations for minimum chromatic aberration, through 5th order accuracy. It will be necessary to mount the whole plate in its final position and to test the plate against the spherical mirror. The final figuring, which is to take care of both the neglect of higher order terms and of the errors of using the above procedure, should be done on the flat side of the plate, in order to obtain good contact between the pitch lap and plate. Such figuring should amount to only a few waves and is no more difficult than the usual parabolization of a mirror, with much less final accuracy required. Of course, the worker must use good technique throughout the procedure. This procedure can be recommended for mass production of correcting plates, once the template is available.

It is not possible to specify an exact value for a; the final correcting plate is independent of a, and a serves merely as an intermediary device. Only values of a greater than one need be considered. When a is 1.1 the amount of glass removed from the cover glass is small, but the cover glass must be thinner to bend to the short radii required. When $a = 1.2$ the amount of glass removed is greater than before and the glass must be thicker to take care of this extra grinding, but that is possible since the bending required is less than before. We have adopted a value of

1.2 for a as a serviceable one. It is unfortunate that the spherical mirror of the Schmidt camera cannot be used as the template, but in that case a is too far different from unity. Of course, if the cover glass is of a plastic material, or is molded and annealed, greater tolerances in the radii are afforded. The writer believes that with proper care it would be possible to use the "dropping" technique employed in making large parabolic reflectors for searchlights, along with carefully trued iron laps of the proper radii of curvature. Moreover it might be feasible to fuse the two pieces of glass together after the fashion of bifocal lenses in spectacles.

To demonstrate the calculation, we shall use an f/2 Schmidt camera of 10 inches focal length. Then h equals 2.5 inches, and R is nearly 20 inches. Let

$n = 1.5$, and $a = 1.2$; then $a_2 = -0.000586$, and $b_2 = +0.0000625$.

$(a')^3/b' = +0.010989$
$a' = +0.22232\ (b')^{1/3}$
$a_2 = -0.000586 - 0.22232\ (b')^{1/3}$
$b' = +0.00006334$
$a' = +0.008862$
$a_2 = -0.009448$

$r_2 = -52.92$ inches
$as_1 = +0.044310$
$rs_1 = +11.28$ inches
$as_2 = +0.053172$
$rs_2 = +9.40$ inches

The above calculation can be carried out for any such aspherical surface, depending on the required values of a and b. The Schmidt plate serves only as an example.

The procedure described above is suitable for constructing the comparatively inaccurate surfaces of a correcting plate but not aspherical mirror surfaces. It may be, however, that such a procedure will prove useful in making grinding and polishing tools for an aspherical mirror. One may go a step further and make a completely achromatic plate by having the plano-convex lens of flint glass, and by choosing a somewhat different set of curves. However, the usual form of correcting plate is sufficiently achromatic for moderate curvatures, and the possibility of using ordinary kinds of glass recommends itself.

HARVARD COLLEGE OBSERVATORY, AUGUST 26, 1939

The Testing of Secondary Mirrors for Cassegrainian and Gregorian Telescopes

By JAMES CUFFEY

Three methods of testing have been proposed and used in the figuring of secondary mirrors for compound reflecting telescopes. They are: (1) Ritchey's autocollimation test, in which the secondary and primary mirrors are set up as they are to be placed in the telescope and used to manufacture parallel light, which is reflected back into the system by a flat mirror of roughly the same size as the primary mirror; (2) Hindle's test, in which a spherical mirror is used to form an image which is in turn projected back to the main focus by the secondary; and (3) a test for Gregorian secondaries, used by Kirkham, in which a test pinhole is

placed in the position to be occupied by the focal plane of the main mirror. A knife edge is then used to examine the image, which is formed farther from the mirror than the pinhole, just as will be the case in the telescope. Of these tests, the first and second have the advantage in sensitivity, since two reflections take place from the surface of the secondary.

Both Ritchey's and Hindle's methods of testing have a disadvantage in that they require accurately figured auxiliary surfaces of roughly the same size as the primary mirror. Furthermore, a difficulty common to all three methods of testing is that the surface being tested is so far from the eye and subtends such a small angle that testing requires acute vision if the details of the surface are to be seen. Usually, the focal ratios involved in the testing set-up are F 15, or greater, while the surfaces of the secondaries have, in general, radii which would make them equivalent to F 7 if tested at their centers of curvature. It is the purpose of the present article to examine the possibilities for testing the secondaries at their centers of curvature, without the disadvantages mentioned above.

In brief, the method proposed is as follows: to make a concave mirror having a prescribed set of zonal radii when tested at the center of curvature in the usual Hartmann or Foucault manner, and then to figure the Cassegrainian convex by placing it in contact with the concave mirror and obtaining straight fringes in monochromatic light, just as in testing flat surfaces. Usually a glass tool is used for obtaining the convex surface, and it is little extra trouble to polish the concave tool, bring it to the prescribed set of zonal radii, and then to use it for testing the convex mirror, which is, of course, the one used in the telescope.

Since the Cassegrainian telescope is apt to be the more useful, we shall work out the zonal radii to be obtained when testing at the center of curvature. The mirror must be hyperbolic in cross section, for this is the conic section with a surface between the two foci, in which the tangent to the curve bisects the angle between the focal radii to the point of tangency.

The fundamental principle which underlies all testing at the center of curvature is that one measures the positions of the intersections of the normals from the surface with the optical axis. In deriving the zonal radii, we must first find the equation of the normal to the curve, and then solve for x when $y = 0$ in order to locate the intersections of the ray with the x, or optical, axis.

The graph of the hyperbola whose equation is

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1,$$

in which $b^2 = c^2 - a^2$, has the following well-known properties: The separation of the two foci is $2c$, and the distance from the primary focus to the surface of the convex secondary is $c - a$. The distance from the convex to the secondary focus is $c + a$. Thus, the secondary image is

larger than the primary image by the factor

$$\frac{c+a}{c-a}.$$

The slope of the tangent to the hyperbola at any distance, r, from the x, or optical, axis is

$$m_1 = \frac{dy}{dx} = \frac{b}{a}\,\frac{\sqrt{b^2+r^2}}{r}.$$

The slope of the normal to the curve at this point is

$$m_2 = -\frac{1}{m_1} = \frac{-ar}{b\sqrt{b^2+r^2}},$$

and the equation of the normal is

$$y - r = \frac{-ar}{b\sqrt{b^2+r^2}}\,x + \frac{a^2}{b^2}r.$$

The intersection of the normal with the x-axis is obtained by setting $y=0$ and solving for x. Thus,

$$x = \frac{c^2}{ab}\sqrt{b^2+r^2}.$$

For zones near the center of the mirror, r is small, or zero, so that

$$x_0 = c^2/a.$$

The difference ΔR between the intersections, or knife edge readings, of a zone at a distance r from the optical axis and the central zone is obtained by subtraction,

$$\Delta R = x_r - x_0 = \frac{c^2}{ab}(\sqrt{b^2+r^2} - b), \tag{1}$$

and the radius of curvature of the convex is $R = b^2/a$. In applying the equation, we must remember that if the pinhole is stationary ΔR will be twice as large as the value given by (1).

A similar treatment may be made for the ellipsoidal mirror of the Gregorian telescope. The results are summarized as follows: the equation of the ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$$

where $b^2 = a^2 - c^2$. The separation of the two focii is $2c$, and the distance of the secondary mirror from the nearer focus is $a - c$. The amplifying factor is

$$\frac{a+c}{a-c},$$

and the zonal radii are given by

$$\Delta R = x_r - x_0 = \frac{c^2}{ab}(\sqrt{b^2-r^2} - b). \tag{2}$$

The radius of curvature of the concave is $R = b^2/a$.

It is interesting to obtain the zonal radii for the parabola by the above method. We have

$$y^2 = 2Rx, \quad m_1 = dy/dx = R/y, \quad m_2 = -y/R;$$

the equation of the normal is

$$x = (r^2/2R) + R - y$$

and, setting $y = 0$, we have

$$x = (r^2/2R) + R.$$

For the central zones, r is small, so that $x_0 = R$. Thus,

$$\Delta R = x_r - x_0 = r^2/2R. \qquad (3)$$

Application of the binomial expansion to the radicals in equations (1) and (2) will permit the terms in parentheses to be written as $r^2/2b$ and $-r^2/2b$, respectively, since r is always small combared with b.

The above method of testing was worked out in designing a Cassegrainian arrangement for the 36-inch reflector of the Goethe Link Observatory (Brooklyn, Indiana). The original intention, to figure the convex by placing it in the telescope and testing on the stars, would have been inconvenient, and would have taken time away from other observational programs. By applying the equations given, there should be no difficulty in figuring accurately either Cassegrainian or Gregorian secondary mirrors without the need for large auxiliary optical surfaces.

KIRKWOOD AND GOETHE LINK OBSERVATORIES, JULY 28, 1939.

Planet Notes for March, 1940

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. The sun's apparent motion will carry it from the constellation Aquarius into the constellation Pisces during March. It will reach the vernal equinox on March 20 at $18^h\ 24^m$, which instant marks the beginning of spring.

Moon. Phenomena of the moon will occur as follows:

			h	m
Last Quarter	March	1	2	35
New Moon		9	2	23
First Quarter		17	3	25
Full Moon		23	19	33
Last Quarter		30	16	20
Apogee	March	9	5	
Perigee		23	10	

Eclipses. A penumbral lunar eclipse will occur on March 23. The closest approach of the moon's limb to the umbral shadow cone of the earth will be 29'.2, so that the eclipse will probably be unobservable. Circumstances of the eclipse, by A. Pogo, appear on page 6 of the January, 1940, issue of POPULAR ASTRONOMY.

Mercury. The unusual configuration of all the naked-eye planets, described in "Planet Notes for February" will still be visible during the first few days of March. Mercury will not be a member of the configuration for long, however, as its eastward elongation from the sun will be rapidly diminishing. Mercury will reach inferior conjunction with the sun on March 15.

Venus. Venus will be a brilliant evening star during March. Its stellar magnitude increases from —3.6 to —3.8 during the month. The planet is moving north quite rapidly so that its position is improving from the point of view of its accessibility to northern observers. On March 1, its declination will be +8°.5, while on April 1, the corresponding figure will be +21°.7. Numerical data pertaining to the planet are tabulated on page 28 of POPULAR ASTRONOMY for January, 1940.

Mars. Mars will be moving steadily eastward during March, not far from the ecliptic. It is diminishing in brightness, and by the end of March will be of stellar magnitude +1.6. On March 16, Mars comes into conjunction with the planet Uranus, the latter being then situated on the same hour circle as Mars and 1° 6′ to the south.

Jupiter. Jupiter is approaching conjunction with the sun, and will be inconspicuous in the evening sky by the end of March.

Saturn. Saturn, also, will be drawing nearer to the sun during March, and will be too low after sunset for satisfactory telescopic examination.

Uranus. Uranus can still be found in the evening sky. During March it will be situated some 40′ south of the 6.3 magnitude star, 53 Arietis, its apparent motion then being slowly eastward.

Neptune. Neptune will reach opposition on March 14, at a point in the constellation Virgo not far from the star β Virginis. A chart illustrating the apparent motion of Neptune from January 1 to September 1, 1940, appears on page 31 of POPULAR ASTRONOMY for January, 1940.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date			IMMERSION Greenwich		Angle E from		EMERSION Greenwich		Angle E from
			h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.										
Mar. 3	BD—18°5079	6.5	10 23.8	—1.7	+1.5	72	11 46.4	—1.9	+0.3	281
18	68 Gem	5.1	23 20.5	—1.7	—1.3	131	0 31.4	—2.1	+0.9	252
20	84 B.Cnc	6.4	0 19.6	—2.0	+1.4	73	1 23.7	—1.4	—2.1	322
20	A^2 Cnc	5.7	7 26.3	—0.2	—0.9	74	8 10.8	+0.4	—1.9	320
25	*h* Vir	5.4	4 10.5	—0.8	—0.9	146	5 11.8	—1.9	+0.7	262
27	34 Lib	5.9	3 46.6	—0.7	+1.2	94	4 50.2	—0.8	+0.3	300
27	ζ Lib	5.6	4 56.5	—1.0	+0.6	111	6 8.2	—1.4	+0.4	284
30	95 B.Sgr	5.8	8 59.9	..	..	31	9 47.6	..	..	324
OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.										
Mar. 3	BD—18°5079	6.5	9 57.0	—0.9	+1.4	90	11 12.2	—1.3	+1.0	270
18	26 Gem	5.1	2 42.6	—2.1	+0.6	61	3 41.8	—0.8	—3.1	322
18	68 Gem	5.1	22 53.4	—1.6	—1.3	140	23 49.6	—1.6	+2.6	234
19	84 B.Cnc	6.4	23 46.4	—1.4	+1.2	87	0 57.8	—1.6	—0.5	300
20	A^2 Cnc	5.7	7 22.1	—0.6	—1.2	95	8 18.5	0.0	—1.8	303
20	*h* Leo	5.3	23 50.1	—1.0	+3.0	57	0 33.3	—1.0	—2.0	337
27	ζ Lib	5.6	4 46.6	—0.1	—0.3	139	5 40.7	—1.2	+1.6	255
30	95 B.Sgr	5.8	8 19.4	—1.4	+2.4	55	9 21.0	—1.1	—0.1	308

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.

Mar. 1	29 Oph	6.4	10	22.5	..	..	13	10	25.1	..	..	9
18	26 Gem	5.1	1	35.9	—2.1	+0.6	90	3	2.7	—2.2	—0.6	282
20	A^1 Cnc	5.7	4	30.0	—2.2	—0.1	96	5	48.4	—1.6	—1.8	306
20	A^2 Cnc	5.7	7	3.8	—1.0	—2.2	137	8	7.8	—1.4	—1.0	266

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Asteroid Notes

By HUGH S. RICE

There are two of the larger asteroids that can be picked up, and followed easily with small telescopes, during February and March of this year. By means of the directions herewith they may be located on a star atlas and afterwards found in the heavens, or they may be located directly in the sky. The best method is to plot the short arc on the atlas by means of our given positions.

Ceres is in a very favorable position for observation. On the evening of January 27 it is 3° north of Denebola, from which place it goes to a point 4° northeast (by east) of the star δ Leonis on March 3. On April 8, the asteroid is 4° northwest of the same star or about 1° west of 64 Leonis. The magnitude is approximately 7 during this entire period, so that the planet is visible in a 2-inch telescope.

Pallas also is not badly placed at this time, as it performs a large curve east of Sirius, going in a northerly direction during February. The positions are: February 4, just south of ο Canis Majoris; February 16, 5° southeast of Sirius; March 3, 5½° northeast of Sirius; March 18, 2½° east of Messier 50 Monocerotis; April 6, 5½° south of Procyon. The magnitude of Pallas changes from 6.8 to 7.4 during the period.

Up to the present time, it has been inconvenient for the Coppernicus Institut, the minor-planet headquarters in Berlin-Dahlem, to issue the annual *Kleine Planeten*. However, many of the important ephemerides, as well as observations, are still published in the special bulletins, which, fortunately for the science of astronomy, are still arriving, the trip from Berlin to New York occupying three weeks.

Hayden Planetarium, American Museum of Natural History,
New York City, January 11, 1940.

Comet Notes

By G. VAN BIESBROECK

The year that just closed has seen a great deal of cometary activity. No less than 12 discoveries were announced, not to mention a thirteenth one which remained unconfirmed. However, most of these were recoveries of expected periodic comets, whose return had been very successfully predicted through the efforts of

the computing section of the British Astronomical Association. Only one of these objects, namely PERIODIC COMET WOLF II, failed to show up in the predicted favorable position. It was missed also at its previous return in 1932 and besides, owing to a near approach to Jupiter in 1936, there have been large perturbations since that time which makes the prediction very uncertain. The region of the comet is still well in reach. A new computation by A. E. Levin and Kennet Pollock (*Journal Brit. Astr. Assoc.*, **49**, 353, 1939) leads to an improved search ephemeris (1940.0), as follows:

1940	α	δ
0^h U.T.	h m	° ′
Jan. 12	9 2.3	—14 41
20	8 55.3	15 57
28	47.6	16 44
Feb. 5	40.0	17 3
13	33.0	16 56
21	27.3	16 29
29	23.4	15 45
Mar. 8	8 21.4	—14 51

There is still a good chance that the comet might be recovered early this year. The predicted date of perihelion was September 14.8, 1939, but after that date the distance from the earth was decreasing until the middle of January. The object is presumably quite faint.

As the year begins there are no known comets in reach of medium sized telescopes. But some of the objects found last year, now very faint, can be recorded yet with powerful telescopes.

In the early evening PERIODIC COMET 1939 *m* (FAYE) can be observed in the constellation of Aquarius. On January 6 it was recorded by the writer as a small round nebulosity of magnitude 15. It comes to perihelion on April 23 but the distance from the earth is increasing so that there will be only a small gain in brightness.

Another evening object, COMET 1939 *n* (FRIEND), was last recorded here on January 9 and it is very doubtful whether it will be followed further. Since the middle of December when the total magnitude was about 11 the comet has become more and more diffuse while fading rapidly. Early in January there was very little condensation in the coma and on the last day mentioned it was reduced to a vague nebulosity not brighter than of 15th magnitude.

PERIODIC COMET 1939 *g* (BROOKS II) is still favorably situated in the constellation of Cetus. It appeared as a small round nebulosity of magnitude 15.5 when last recorded here on January 6. Its increasing distance both from the sun and from the earth reduces the magnitude gradually.

A fourth object, whose period of visibility may extend from last year into the present, is COMET 1939 *h* (RIGOLLET). When last observed here on December 22 it had become very diffuse and hardly brighter than magnitude 16. It is, however, favorably located in the constellation of Canes Venatici and may still be followed for some time.

Williams Bay, Wisconsin, January 11, 1940.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By **CHARLES P. OLIVIER, President**

This past December a number of our observers braved the cold winter nights and made observations on the Geminids. In most cases they were well rewarded by seeing large numbers, including many bright objects. The details of those reports now at hand will follow. For the benefit of persons not very familiar with meteors may I state that, next to the Perseids of August, the Geminids of December now furnish, in the average year, the best of all meteor displays. Obviously we exclude from this remark such exceptionally great showers as those of 1933 October 9 and 1931 November 16. Also occasionally, the Orionids in October give a better display than usual and may surpass the Geminids. But in the long run we may class the three showers mentioned in the order: Perseids, Geminids, and Orionids. It would be difficult to make a choice for fourth place as the Bielids seem eliminated entirely from activity, and the Quadrantids, Lyrids, Eta Aquarids, and Delta Aquarids are erratic in their hourly rates, some years being awfully low, others good, with little data for prediction as to when higher rates might be surely expected. As for the lists of "minor showers" with which many publications are cluttered, I personally pay no attention to them. Some of them certainly exist, and if one observes enough hours on a given night, he will get radiants, at least in some years, which agree with published positions, but in other years he probably will not. As the word "shower" denotes something at least fairly worth seeing, it is too bad that the word is used to designate streams which may furnish one meteor or less per hour—or per night!—even when at maximum. I often have had persons send me lists of "minor showers" asking that I check them. This I do with great reluctance, for I have serious doubts about the reality of much of it. True the A.M.S. has published over 2000 radiants, and perhaps 40% of them have been confirmed in one or more subsequent years. But even at that, maturer judgment makes me fear that, with all the precautions I certainly took, very many of the 2000 represented either errors of plotting or chance intersections of projected paths. Hence my strong advice to observers is to forget that lists of minor radiants exist, and to observe on each night as if nothing was known about radiants. (Of course this does not apply to the very few well-known streams mentioned above by name.) If a man will observe for several hours on a given night, he has every chance of independently finding from his plots where radiants are situated. In some cases at least these will coincide with published positions in lists of competent observers. But only when a radiant can be picked up, year after year, with some certainty should the meteors which define it be said to furnish a "shower," or a "stream," though the latter term is much less objectionable. Reform along this line will come in time, but due to the heterogeneous mass of data existing at present, it is difficult to realize. It is, however, comforting to remember that the A.M.S. was the first large group of which I know to issue rather rigid rules on the subject. These have been made even more rigid here and elsewhere as time went on, so that now the farcical "radiants" of the period 1850 to 1910 would hardly be given out by a reputable observer. This remark of course does not imply that many excellent lists or single radiants were not obtained in that interval, but refers only to those based on a handful of meteors over periods of from 3 to 60 or more days! Such

lists formed the basis for belief in "stationary radiants," things firmly believed in 40 years ago by many despite their obvious impossibility on theoretical grounds for most parts of the sky. So while we have still far to go before our radiant lists contain only realities, great progress has been made, and the A.M.S. was the pioneer in this reform.

As a final matter of advice to our observers, if one will observe for 4 hours on one average night he does more good by far in radiant determination than if he observed 1 hour each on 8 nights. Lists of expected hourly rates for every month —for nights without moonlight and with clear skies of course—are furnished in A.M.S. Bulletin No. 15. If every member could, once per month, put in 4 hours of work on a single night (it does no harm to have a rest period in the interval), the results for a given year would have a value never yet attained. As it is, a few do more than this, most much less, many almost or quite nothing. It would be a great thing if 1940 could see a true revival of interest among our membership and a determination on the part of each to contribute a full share. It is well known to me that a program as ambitious as that mentioned is quite impossible to many members and we welcome their contributions no matter how small or infrequent. But it does no harm to have a goal which it would be very desirable to reach, and the above expresses that thought. Full supplies of new maps, blanks, etc., are now on hand and can be furnished all members at their request. Finally, will all in the A.M.S. please send in their final reports for 1939 *at once?* Regional directors particularly please heed!

With regard to the tabular matter, the long report from the group under Dr. Donald Faulkner of Stetson University, Deland, Florida, is the outstanding contribution. Evidently a fine shower was seen there on December 12, but unfortunately at their second station at Cocoa, 52.2 miles away, rain and clouds interfered, conditions becoming impossible after midnight so that the parallax program fell through. However, a large amount of excellent data was secured, which will be worked up here. The 209 meteors plotted at Deland were all brighter than 3 magn. and many were brilliant. Over 1500 were seen by this party of 5 plotters and 1 re-

Observer and Station	Date 1939	Began	Ended	Min.	F.	Met.	Rate	*
Faulkner, D. +, Deland, Fla.	Nov. 15	12:00	16:00	?	?	47		(1)
Faulkner, D. + 5, Deland, Fla.	Dec. 12	12:20	17:36	316	1.0	1500		(2)
Wood, R. J. + 1, Cocoa, Fla.	12	7:45	13:00	?	?	52		(3)
Heaton, G. + 1, University, Ala.	12	11:35	12:50	75	1.0	48		(4)
	13	11:15	12:25	70	0.8	17		(5)
Dole, R. M., Cape Elizabeth, Me.	11	11:15	12:25	70	1.0	19		(6)
	12	12:00	13:15	75	1.0	37		(6)
	14	10:	12:	120		0		(6)
Stone, W. R., Santa Barbara, Calif.	12	9:45	14:15	270	1.0	22	4.9	(7)
	13	10:	14:	240	1.0	24	6.0	(8)
Jewett, Miss M.,	Nov. 9	15:	16:	60	1.0	4	4.0	(9)
Grandview, Tennessee	10	12:30	14:45	120	1.0	17	8.5	(9)
	Dec. 11	8:	9:30	60	1.0	5	5.0	(9)
	13	10:	14:20	125	1.0	49	23.8	(9)
Leerman, J., Baltimore, Md.	13	13:05	14:05	60		13	13.0	(9)
Mastell, R., Hibbing, Minn.	13	11:30	12:30	60	1.0	48	48.0	(9)
Smith, F., Thiells, N. Y.	Oct. 9	6:55	8:05	70	1.0	5	4.3	(9)
	15	9:05	10:05	60	1.0	3	3.0	(9)
	Dec. 12	10:55	11:55	60	1.0	4	4.0	(9)
	14	10:55	11:25	30	1.0	2	4.0	(9)

NOTES: (1) 45 plotted; interrupted clouds. (2) 209 plotted. (3) 50 plotted; F 1.0 to 0.0. (4) 25 plotted. (5) 17 plotted. (6) all plotted; 52 Geminids. (7) 22 plotted. (8) 24 plotted. (9) counts.

corder. Dr. Faulkner was assisted by: Mr. Hayes, Knorr, Hardeau, Lumpkin, and Smith; at the other station were Wood and Hido. When the rates are omitted in the table it is because the meteors were jointly recorded by more than one person, or, in Dole's case, because he does not, as a rule, record sporadic meteors.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1940 January 12

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
Department of Astronomy, University of California, Los Angeles

President of the Society: H. H. NININGER, Colorado Museum of Natural History and American Meteorite Laboratory, Denver
Secretary of the Society: ROBERT W. WEBB, Department of Geology, University of California, Los Angeles

Supplement to an Astronomical Theory of Tektites*

By W. CARL RUFUS,
Observatory, University of Michigan, Ann Arbor

1. *Composition.*—The composition of the parent magma is not well known, but the silica content of some magmatic ores rises to 93% to 96% and the alumina content (second in tektites) rises to 60%.

The difference between tektites and natural terrestrial glasses has been frequently emphasized, but the greater difference between tektites and meteorites has not been equally stressed. The following comparison indicates these relationships.†

MATERIAL	EARTH	TEKTITES	METEORITES
SiO_2	59.12%	70% - 80%	14% - 31%
Al_2O_3	15.34	12 - 15	1 - 2.3
MgO	3.49	Small - 2.6	7.9 - 19.0
FeO	Small	2.6 - 5.4	4.5 - 11.0
Fe_2O_3	3.08	0.37 - 1.07	<0.75
K_2O	3.13	2.5 - 2.8	0.05 - 0.13
Na_2O	3.84	Small - 2.5	0.27 - 0.66
CaO	5.08	0.26 - 2.46	0.67 - 1.50

2. *Motion.*—The periods of orbits need not be restricted to one day. Eccentric orbits with perigee near the point of rupture would bring the swarms periodically to lower heights. Periods might be even less than one day, like that of the inner satellite of Mars, which would accord better with lower heights.

3. *Distribution.*—The proximity of the great tektite falls to the deepest trenches of the Pacific is of special interest. Four trenches with depths exceeding 9,000 meters are located in a zone near by and parallel with the great belt of tektites including Indo-China, the Philippine Islands, Malaysia, the East Indies,

*Read at the Seventh Annual Meeting, Columbus, Ohio, 1939 Dec. 28-30. The original paper on "An Astronomical Theory of Tektites" appeared in the January, 1940, issue, pp. 49-51, *q. v.*

†The mean value for volcanic rocks, characteristic values for tektites, and mean values for meteoritic accretion by Fletcher G. Watson, Jr., are compared, using elements of greatest abundance.

and Australia. The deepest trench, 10,500 meters, lies just east of the Philippines. Others are near Guam, New Guinea, and Tonga. The real significance of these trenches is not clear, but they constitute certainly a center of great tectonic disturbances. The depths extend evidently to the basaltic layer of the earth's crust.

A Meteor Train Photographed from an Airplane*

By OSCAR E. MONNIG,
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ABSTRACT

Two photographs, taken 1939 April 29, by Mr. John H. Spikes (photographer) and Capt. D. Z. Zimmerman (pilot), from an altitude of 9,300 feet about 20 miles east of Salem, Alabama, show what the writer interprets as a meteor train. The train is about 13° long on the first picture and 8° on the second. It shows marked distortion and some "doubling." There are apparently insufficient data and too many unknown variables of motion involved to allow any satisfactory computations of the train's true position, height, or drift, but the upper-air winds were probably from the west and/or north. No confirming observations of the daylight meteor which presumably caused the train have been secured. Nevertheless, the object shown is thought to be certainly a meteor train. If it is, the photographs are unique in having been taken from an airplane.

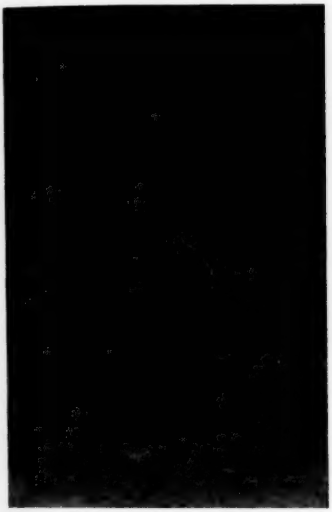

FIGURE 1

Earlier Photograph of Probable Meteor Train. Taken about 10:20 A.M., E.S.T., 1939 April 29.

FIGURE 2

Later Photograph, Taken Probably Several Minutes after the Preceding (Fig. 1). Note marked changes, especially apparent doubling and twisting.

*Read at the Seventh Annual Meeting.

An Unexplained Craterlet Near Chickasha, Oklahoma*

By OSCAR E. MONNIG *and* ROBERT G. BROWN,
312 W. Leuda St., Fort Worth, Texas

ABSTRACT

An elliptical depression, about 80 × 110 feet, in a wheat field which has been cultivated for about 35 years, just east of Chickasha, Oklahoma, was investigated in a preliminary way by photographing it from an airplane, checking its local history, and digging three test holes in it. No positive evidence of any single mode of origin was adduced, although there seems to be at least some slight possibility that it is meteoritic.

*Read at the Seventh Annual Meeting.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Nova Monocerotis 1939: Dr. Fred L. Whipple, from the examination of a spectrum image secured on a plate taken December 15, 1939, has found another typical, galactic nova in Monoceros.* The star appears on numerous photographs exposed since October 17, when it was at magnitude 8.5; by the end of the year it had faded nearly to the tenth magnitude. On plates taken in April, 1939, or earlier, no trace of the object could be detected.

Immediately upon discovery, December 24, a chart with a provisional sequence was prepared and sent to a few observers so that the decline in light might be followed visually.

From photographic observations made by Dr. Whipple, the light curve resembles the transition portion of the light curve of an earlier nova found in the same constellation, Nova Monocerotis 1918. Accordingly, Whipple's nova might well have been at its maximum, magnitude 5.0 or brighter, in September, 1939. The provisional light curve is shown in Figure 1.

Supernova in Spiral in Cetus: Still another supernova has been found by Dr. F. Zwicky at Palomar. The star appears on a plate taken December 4, 1939, in one of the spirals associated with several NGC nebulae in the constellation of Cetus. The nova was estimated as fainter than magnitude 17.5 on November 2, as of magnitude 16 on December 4, and magnitude 16.5 on December 14. It probably attained maximum, about magnitude 15, on about November 20. The estimated distance of this spiral is of the order of seven million parsecs, or 23 million light years, which would indicate an absolute magnitude for the nova of approximately −14.

Zeta Aurigae: The long-period eclipsing variable Zeta Aurigae was observed on its recent decrease to minimum by Dr. F. E. Roach of the Stewart Observatory. His photoelectric observations were made between December 16 and 22, 1939. Partial phase began December 19.22 (U.T.), J.D. 2429616.72 (G.M.T.), and ended

*The nova was independently found by Wachmann at Bergedorf.

December 21.22 (U.T.), J.D. 2429618.72 (G.M.T.), exactly a two-day interval being required for the drop from maximum to minimum magnitude. Accordingly, the rise should begin on January 26.22 (U.T.) and end two days later, on January 28.22 (U.T.), if we assume that minimum phase, from first to last contact, occupies exactly forty days.

Dr. Roach finds that there is a peculiarity in the form of the light curve a few hours after totality begins; a brightening to the extent of three-hundreths of a magnitude. It will be of interest to note whether a similar feature occurs at the end of totality.

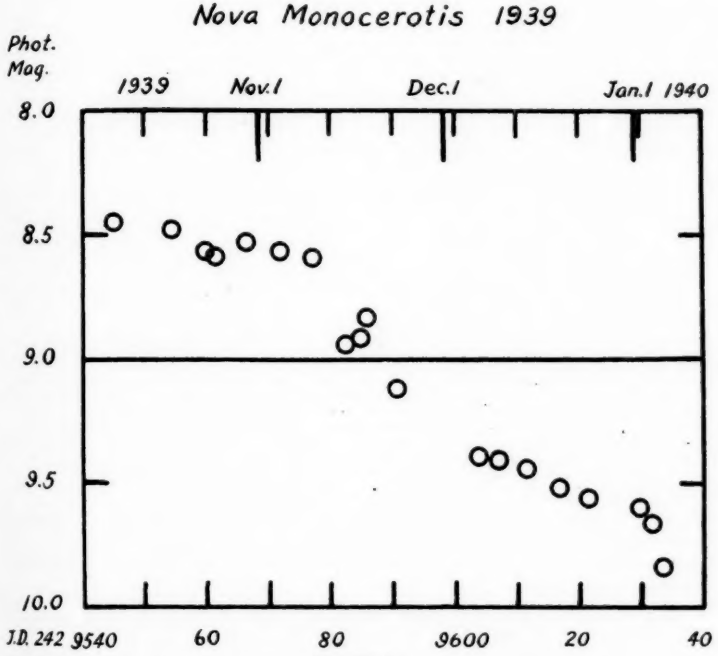

FIGURE 1
MEAN PHOTOGRAPHIC LIGHT CURVE OF NOVA MONOCEROTIS 1939

According to Schneller's Catalogue for 1939, this eclipsing variable has a period of 972 days and varies from magnitude 4.9 to 5.6, photographic. The spectral types of the two components are K5, supergiant, and B9, a main sequence star.

An interesting feature concerning the light variation of this star is the difference in range for different wave-lengths. For example, at λ3800 the range is of the order of two magnitudes, while at λ5900 the range barely exceeds one-tenth of a magnitude. Mean radii and masses for the components of ζ Aurigae have been computed by S. Gaposchkin. The radius of the heavy component is 245 times that of the sun, and for the lighter component, 4.9. Masses are 972 and 16.4 times the mass of the sun, respectively.

Variable Stars in High Latitude Field 354: In the course of a recent investigation carried on by Sr. Luis E. Erro, an A.A.V.S.O. member from Mexico City on leave of absence from the Mexican Embassy at Washington during the early months of 1939, twenty new variables were found in HLF 354 (high-latitude field), centered at R.A. $11^h\,32^m$ and Decl. —35°. Only nine variables had been previously reported in this field, seven having been discovered by Luyten in the course of his extensive proper motion program, one by Hoffmeister, and one, TW Hydrae, by Gerasimovič. No certain variation could be detected by Erro for this last object.

The list of 29 variables so far found in this particular high latitude region includes, segregated according to type: SS Cygni, 2; R Coronae Borealis, 1; eclipsing, 5; cluster, 6; long-period, 9; W Ursae Majoris, 1; semi-regular, 1; uncertain, 1.

The median magnitude for the six cluster-type variables is 12.6. Periods for the long-period variables average 265 days, ranging from 117 to 367 days. This average value agrees well with that found for such objects in general. The single R Coronae Borealis-type star, maximum magnitude 12.2, appears to have undergone one excellent minimum of more than 120 days duration, with several other minima of minor extent indicated.

Of the two stars belonging definitely to the SS Cygni type, one varies between $11^M.9$ and $15^M.4$, with eleven maxima so far observed. Not more than thirty days is occupied in passing through a single maximum. The other SS Cygni star, originally discovered by Luyten, varies from $12^M.1$ to fainter than $16^M.5$. Numerous rises to maximum have been observed, the longest maximum occupying not more than twenty days.

The above research undertaken by an amateur shows what, with proper guidance, can be accomplished by a thoroughly interested person devoting a few months to a study of the photographic plates. Sr. Erro is to be congratulated on the success which he attained in this, to him, a new field of endeavor.

Changing Periods of Variables in ω Centauri: Many years ago Professor Solon I. Bailey studied in considerable detail the Cepheid variables found by him in the cluster ω Centauri, deriving periods and light curves for most of these stars. His work was not only original but fundamental in nature. Some years later, in 1922, Bailey and Shapley planned a program for securing additional plates which would serve, it was hoped, to study possible period-changes in many of the Cepheid variables in the cluster.

Recently Miss Frances Wright has measured and discussed the later plates and shows very conclusively that changes in period for at least seventeen of these Cepheids have taken place, in close agreement with similar results derived at Leiden by W. C. Martin from plates taken at Johannesburg in recent years. The detailed discussion of Miss Wright's results is to appear in a forthcoming Harvard *Bulletin,* with diagrams illustrating the period changes.

Changing Period of U Sagittae: In 1929, A. H. Joy suspected that the period of the eclipsing binary U Sagittae was slightly variable: he found that in the interval between 1902 and 1929 the observed minima showed residuals from his linear elements which roughly followed a sine curve, with a range of 16 minutes and a period of 17 years. Gadomski, in 1935, discussing all published dates of minima, confirmed the variation of the period, but found for the residuals a period of 21 years, with a range of 26 minutes.

Dr. L. Jacchia has recently observed U Sagittae on about 2500 Harvard plates, covering the years 1898 to 1939. Using this photographic material alone, he has

shown clearly that the change in period is real but with a value somewhat larger than that given by either Joy or Gadomski. Jacchia has also re-exminaed all the original, visual observations available, reducing them to normal epochs by means of the latest elements, and in this way he has considerably diminished the uncertainty of the single points on the curve of the residuals. By combining the results of the visual and photographic observations, he finally obtains a period-change covering 30.5 years, with a range of 13.8 minutes, *i.e.,* with maximum departures of ±6.9 minutes from the linear elements. These deviations are extremely small as compared with the period of the star (3.38 days), and Jacchia considers that they are probably due to apsidal rotation in the system itself.

Changes in Period and Light Curve of Delta Cepheids: A recent paper by J. Balaza and L. Detre, of the Budapest Observatory, continues the discussion of the change in period and form of light curve of another Cepheid variable, AR Herculis. The observations discussed were made during the years 1925 to 1939, and totalled 3363. Whereas the mean light curve of AR Herculis is remarkably smooth and typically Cepheid in shape, individual curves are decidedly irregular and fall far short of reproducing the mean light curve. The authors find a period of inequality of epochs of maximum amounting to exactly 67 times the principal period of $0^d.4700$, or $31^d.5$. The changes in the shape of the light curve have the same long-term period, $31^d.5$.

Although the times of minimum show only small deviation from the linear elements, those for maximum have an amplitude of $0^d.061$. Extreme values for the amplitude of variation between different curves are $0^M.90$ and $1^M.77$; a bright maximum is usually followed by a weak or faint minimum, and conversely.

If it is assumed that the long-term period arises through the interference of two nearly commensurable periods, then only the combination of $0^d.46311$ and $0^d.47002$ would seem probable; but if $0^d.47002$ is the period of the primary pulsation, $0^d.46311$ cannot be identified as an overtone period on the basis of any plausible star-model. A careful consideration of the deviations from the mean light curve also makes the interference hypothesis appear improbable. The situation is much like that of δ Scuti, discussed by T. E. Sterne.

The authors conclude that the long-term period of AR Herculis is real, but since it cannot be a free-pulsation period, it must be considered as a forced vibration which affects the short-term period, working differently at different phases of the long period.

Balaze and Detre found in a previous paper that studies of change in period for RW Draconis required the complete light curve, and they had only observations near maximum with which to work. Before discussing the whole problem thoroughly, they wish first to study other typical Cepheids, namely RR Lyrae, XZ Cygni, XZ Draconis, RW Cancri, and RW Draconis.

The Eclipsing System, CC Cassiopeiae: From a study of the spectroscopic and photographic-magnitude observations of CC Cassiopeiae, Dr. S. Gaposchkin has been able to deduce several interesting facts concerning its physical properties. Like four other variables of this type, CC Cassiopeiae is of spectral class O. The period is $3^d.369$, and maximum brightness occurs at about $7^M.0$, the range in variation not exceeding $0^M.2$.

The recently discussed photographic observations give the first idea of the form of the light curve, and therefore the necessary basis for computing, with the aid of the spectroscopic data, the sizes, masses, *etc.,* of the components of the system. Maximum light is essentially constant; consequently the star is of the Algol

type. The following facts are revealed from Dr. Gaposchkin's study:

Mass of larger star	20.0 ⊙	Amplitude of Prin. Min.	$0^M.16$
Mass of smaller star	10.0 ⊙	Amplitude of Sec. Min.	$0^M.12$
Radius of larger star	7.3 ⊙	Absolute Mag. of larger star	−3.2
Radius of smaller star	6.3 ⊙	Absolute Mag. of smaller star	−2.8
Density of larger star	0.05⊙	Duration of eclipse	80 hours
Density of smaller star	0.04⊙		

A rather large color index is to be noted for CC Cassiopeiae, at least $0^M.4$ in yellow light and $0^M.5$ in red, resembling closely the system of Y Cygni, not only in this respect but also as regards the radii of the component stars. All other O-type

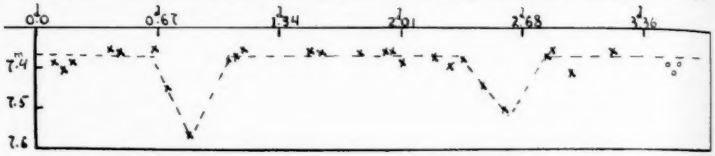

FIGURE 2
THE LIGHT CURVE OF CC CASSIOPEIAE

eclipsing systems are, on the average, about twice the size of CC Cassiopeiae. The light curve derived from the photographic observations is shown in Figure 2, the points being means of several exposures on the same plate. The abscissa is the period expressed in days.

Observers and Observations during December, 1939:

Observer	Var.	Obs.	Observer	Var.	Obs.
Adamopoulos	12	12	Holt	103	252
Albrecht	32	53	Houston	147	430
Armfield	2	2	Howarth	10	10
Baldwin	45	57	Irland	9	9
Ball, A. R.	14	14	Jones	71	197
Ball, J.	13	13	Kanda	3	31
Bappu	33	95	Kearons, Mrs.	53	86
Blunck	31	33	Kelly	17	24
Bouton	51	68	de Kock	56	233
Britzelmayer	6	6	Kozawa	13	47
Buckstaff	17	77	Loreta	165	490
Callum	59	75	Lovinus	9	9
Carpenter	41	41	Lundquist	45	73
Chilton	2	2	Mages	6	6
Cilley	19	42	Maupomé	19	19
Dafter	6	20	McKeon	2	3
Diamantopoulos	8	12	McPherson	45	45
Diedrich	17	21	Moore	14	14
Economou	26	60	Needham	34	38
Escalante	85	185	Palo	20	54
Fernald	97	205	Parker	22	23
Focas	55	96	Peltier	23	84
Gregory	75	82	Prinslow	5	5
Griffin	8	8	Purdy	4	6
Guthrie	3	3	Rense	16	16
Halbach	138	195	Rosebrugh	22	63
Harris	42	50	de Roy	18	59
Hartmann	166	222	Ryder	14	14
Hayner, Miss	3	3	de Santis	5	7
Heckenkamp	3	5	Schoenke	9	10
Heidelberg	6	6	Shafer	4	5
Hildom	11	15	Smith, F. P.	16	16

Observer	Var.	Obs.	Observer	Var.	Obs.
Smith, L.	14	14	Weber	32	32
Topham	150	250	Yamasaki	42	46
Walton	9	27			
Webb	6	6	70		4101

January 15, 1940.

Notes from Amateurs

The New Haven Amateur Astronomical Society

The New Haven Amateur Astronomical Society, at a well-attended meeting on December 16, listened to a talk by Mr. Joseph Kirk, meteorologist in charge of the New Haven Bureau.

Mr. Kirk, in beginning, said that, owing to the position of the New England States, the weather was not very favorable for astronomers in that locality, as all storms follow certain paths and largely the same general paths, one of which passes over New England; some storm paths travel the entire distance around the earth.

Storm centers are often a thousand miles in diameter and always revolve in a counter clockwise direction. Most storms come in from the Puget Sound and pass across the continent just north of the United States and, as a result, during last autumn this country suffered from scarcity of rain and moisture, resulting in the many sections of severe drought in the United States.

Many hurricanes develop off the coast of Africa and travel in a westward direction to near the coast of Florida, then turn northward and follow just off the coast line. The hurricane of September 21, 1938, started near the Cape Verde Islands and was first observed on September 13 by a ship at sea but not reported, again on the 16th it was observed by another ship but again not reported. It was observed by a third ship on the 17th and reported, on the 20th it turned north off Florida but, contrary to the general rule, it turned in toward the land hitting Connecticut and Rhode Island with devastating force. This storm center was traveling at the rate of 55 miles per hour and practically all damage was done on the side east of the storm center.

During the last four years, weather bureaus have greatly expanded their work, there being stations now all over the country. Observations for airways are taken every hour and sent to Newark. If storms are indicated, observations are made every 15 minutes, the heights of clouds (ceiling) are carefully checked, for a miscalculation of 100 feet in a ceiling four to five hundred feet high would mean much to a pilot.

Weather bureaus began studying conditions of the upper air in 1898 by sending up kites and balloons, attached to wires, one to two miles high to record temperatures, humidity, and air pressure in order to give an idea of what was going on up above. The temperature falls one degree for every 300 feet of increase in altitude up to 6 or 7 miles after which it remains nearly constant at 40 degrees to 55 degrees below zero. There are no storms above the 6 to 7 mile level; at the equator this level is 8 to 10 miles.

In place of kites, pilot balloons are now used and as the balloons rise, they are observed by means of a theodolite from the ground and readings at the rate of one every minute are taken and automatically charted showing the motion of the balloons to determine the direction and strength of currents affecting them.

Radio meteorographs are also used, carrying instruments weighing 1½ pounds operated by a flash light battery, which go up to 15 miles and send back messages continuously recording the conditions of temperature, pressure, and humidity through which the carrying balloon is passing. When spent these balloons burst and the recording instruments return to earth by means of small attached parachutes.

All ships make observations four times each day which are sent by radio to Washington and from there are re-broadcast to other ships.

Throughout the United States there are seven forecasting centers, all of which check weather conditions simultaneously at 7:30 P.M. E.S.T.

Mr. Kirk's talk was very interesting, instructive, and well received as was evidenced by the numerous questions asked as only amateur astronomers can ask questions.

F. R. BURNHAM, *Secretary.*

January 12, 1940.

Yakima Amateur Astronomers

The Yakima Amateur Astronomers of Yakima, Washington, an organization of which Mr. Edward J. Newman is president this year, are having an active and stimulating season. Before each of the monthly meetings a four-page leaflet, *The Observer,* is issued, giving items of interest to the members. The organization is also sponsoring a series of lectures by one of its members, the Reverend Louis B. Egan, S.J., who is head of the science department of Marquette High School in Yakima. These lectures are given, one each month, especially for adults who are interested in the principles of astronomy. No charge is made and the audience is not limited to members of the club. Each lecture is outlined in mimeograph forms which are distributed at the beginning of the lecture. A very successful annual banquet was held on December 5.

Venus—The Veiled Mystery

Venus, the one other planet in the solar system nearest to the earth in size and density and the nearest in distance, is least known to us as to surface features and air conditions. The lack of knowledge is due to the fact that while the planet may come within 25,000,000 miles of us the orbit is within that of the earth so that at near approach the dark side is towards us, and to the fact that the atmosphere is so highly reflective that surface markings, perhaps lacking contrast, are more or less effectively veiled by the brilliantly illuminated atmosphere. Venus was believed to have a rotational period of about 24 hours from the observations of Schroeter during the closing years of the 18th century though Bianchini about the same time accepted a period of 24 days. About 1809 Schroeter made a more careful determination and found a period of 23 hours 21 minutes and 9.977 seconds. In 1842 DeVico at Rome deduced a period of 23 hours 21 minutes and 21.9345 seconds. In 1890 Schiaparelli concluded that Venus rotated very slowly, probably as it revolved about the sun. Perrotin found the same slow motion and Terby in the same year published results showing a similarly long period. But in 1891 Niestan published results confirming DeVico's period and somewhat later Trouvelot decided on a period of about 24 hours. About 1895 Brenner affirmed the belief in a period of 24 hours and then Schiaparelli again attacked the problem. He found a period of about 225 days as before and his results were confirmed by Mascari in Sicily and Cerulli in the north of Italy.

These observers saw indistinct markings or, as they supposed, distinct mark-

ings indistinctly, so it was decided Venus has a dense cloud-filled atmosphere much as ours was thought to be in our carboniferous age. In 1895 Lowell at Flagstaff began work on Mercury and Venus and this work confirmed the long period of Schiaparelli for Venus. Lowell found no clouds in the air and by observing in the daytime was able to perceive easily distinct markings but having little contrast to the rest of the surface. He attributed this in part to the brightness of the air which thus veiled more effectively the surface of the planet. On Mercury which has no air but is less favorably situated for observation, Lowell easily saw the crisscross of markings so peculiarly a feature of this planet.

As observers have not all agreed as to the rotation period of Venus the spectroscope has been used on Venus in particular and on the other planets also. While the results on the other planets and the sun have been found to be in close agreement with observed rotational periods the results for Venus were negative and indicate that the planet has a very slow rotation. Similar work at Flagstaff since has given the same result. There also the spectroscope has shown a lack of water vapor in the air of Venus but distinct indications of its presence in the air of Mars.

Results at other observatories have not been in accord. At Mt. Wilson it was found that the spectroscope failed to show water vapor and oxygen in the air of either Venus or Mars and so it is claimed by some that the spectroscope shows only the outer layer of Venusian atmosphere while the lower layers are filled with dense clouds which are open over the tropics and that the planet rotates in a short time like the earth. Rordame, in a lecture reported in POPULAR ASTRONOMY for November, 1922, asserted that since Venus shows an atmosphere all around the planet it must rotate in a short time else if it rotates as it revolves the great heat on the sunward side would drive the air around to the cold side where the great cold would congeal it and thus prevent its return to the hot side. Evidently Rordame had never tried to solidify air or similar gases and such a statement is on a par with the assertion that the polar caps of Mars are carbon dioxide.

Lowell believed that the air of Venus contains fine dust in suspension which accounts for its high reflective power, and he remarked that the planet exhibited on its visible face a drab monotone and lack of contrast beyond that of any other planet. He saw no polar caps on the planet. A little reflection will show that the contrast in temperature between the dark and sunward sides cannot be so great as it would be if Venus lacked air for the air must serve as a blanket against great heat and great cold, and as it circulates from hot to cold side and back again it must further tend to equalize the temperature. It is interesting to note that solar radiation is twice as intense at the distance of Venus as at the distance of the earth while the intensity at Mars is about half so that, to equalize the heating effect of the sun, Venus must be twice as cloudy, or its equivalent, as the earth, and Mars half as much, and that is about what observation indicates.

Sir John Herschel writing nearly 100 years ago about Venus, stated: "The intense lustre of its illuminated part dazzles the sight and exaggerates every imperfection of the telescope; yet we see clearly that its surface is not mottled over with permanent spots like the moon; we notice in it neither mountains nor shadows, but a uniform brightness, in which sometimes we may, indeed, fancy, or perhaps more than fancy, brighter or obscurer portions, but can seldom or never rest fully satisfied of the fact. It is from some observations of this kind that both Venus and Mercury have been concluded to revolve on their axes in about the same time as the earth, though in the case of Venus, Bianchini and other more recent observers have contended for a period 24 times that length." "Outlines of Astronomy."

Later English observers seem to have turned their attention to Mars, Jupiter, and Saturn, planets more satisfactory for study.

While it is thought by some that Venus rotates rapidly and is cloud wrapped, our earth is estimated to be only 50% cloudy and we know that clear air offers but little obstruction to vision or photography. Also our clouds shift around with storm movement and no part of our globe is permanently cloud wrapped. If the brightness of Venus is due to clouds they do not change place or shift over the dark areas which seem to be fixed in place in respect to limb and terminator. Ultra-violet photographs indicate some shifting of light areas but show that the dark areas are always based on the terminator and taper towards the center of the sunward side of the planet. Polar caps seem to be absent and this indicates either lack of moisture or a slow rotation though not necessarily synchronous with its revolution. While not well placed for observation as is Mars it seems that if the illuminated face of Venus were alive, had patches of vegetation, seas and mountains, polar caps and belts of cloudiness, we would see such prominent features easily through an atmosphere that can not be denser or deeper than our own. Instead there seems to be the monotone of a general drabness, such as we can expect a desert to show, veiled by a considerable atmosphere that probably carries much fine dust but is free of storm clouds or areas of mist such as we have here and occasionally see in Mars. That we cannot see anything of interest on the face of Venus may be due to lack of distinct features as well as to their veiling.

It has been asserted that the sun has not synchronized the rotation of Venus with its revolution, since the combined tidal effect of the sun and moon on the earth is greater than that of the sun or Venus. This is fallacious reasoning, for the sun, earth, and moon do not remain in the same straight line and one of the attracting bodies soon reduces any tidal bulges raised by the other on the earth. There can be no considerable tidal evolution without tidal bulges and our moon may be of considerable help in delaying the tidal evolution of the earth. If we take Mercury as a unit and consider that tidal action is diminished as the cube of the distance and is further modified by the diameter and density of the affected body, we find the tidal effect for Venus nearly one-fourth that for Mercury and that for the earth one-third of the tidal effect on Venus. Leaving the moon out of consideration, the earth should rotate 3 times as long as Venus was permitted by the sun. The effect of the moon may extend this time indefinitely for the moon's time of revolution is long as compared to the rotation time of the earth, these times are not commensurate and the tidal effect of the sun and moon can not be cumulative.

If Venus is not now a fit abode for life it must have been in the past, since it is so like the earth in size and density and in depth of air. The greater heat of the sun there may be screened by the reflective power of the atmosphere, or races of plants and animals, adapted to the greater heat there, may have been evolved. If life was once abundant on the planet and was later exterminated by the effects of tidal evolution it was a planet-wide destruction of life instead of the somewhat localized catastrophes that occurred on the earth in the past and are still occurring, when life is destroyed over large areas by drouths, floods, tidal waves, earthquakes, volcanic eruptions, and extensive forest fires.

Daylight observations with good telescopes, located in favorable spots in or near the equatorial regions, may give us more direct knowledge of Venus. Using diaphragms over the objective and using moderate powers will be an aid to definition much needed on the bright planets and especially on Venus.

The ultra-violet photographs of Venus taken at Mt. Wilson deserve study be-

cause most of them corroborate direct views in a telescope and besides they show a shifting of light and dark areas in respect to the equator and the close relation of dark areas to the terminator. It should be remembered that it is near the central parts of the disc of Venus that we may more readily see through the atmosphere while at other points our line of vision makes sharper angles with the spherical surface of the outer air. Whether the light area is cloud, mist, or dust, it seems to be disturbed most near the terminator as if by currents of air moving into the heated hemisphere. These photographs have been published elsewhere, and consequently are not included here.

W. E. DUCKWALL.

Box 441, Hillsboro, Ohio, December 2, 1939.

A Cross-Hair Alignment Instrument of Newer Design

In the issue of POPULAR ASTRONOMY for October, 1936, (Vol. XLIV) there appeared an article under the title, "Cross-Hairs for Your Telescope," written for the purpose of passing on to the amateur a design which would enable him to construct his own reticules.

Since that article was written the author has constructed an instrument of

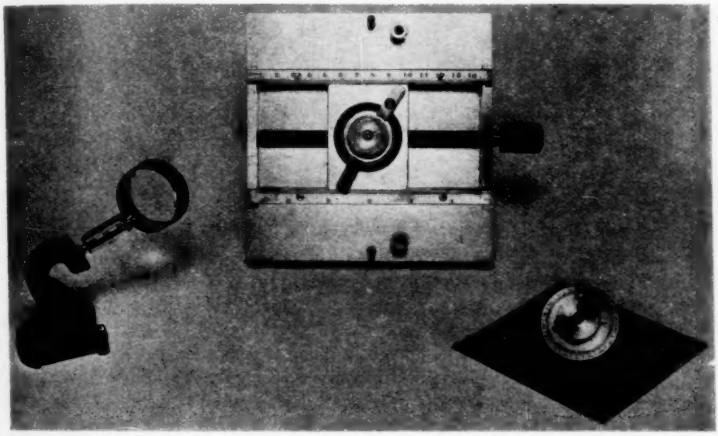

FIGURE 1

newer design embodying a wider scope of usefulness in that it enables the operator to place on the friction ring a cross-hair at any given angle by simply revolving a dial after first having placed the standard cross-hairs at right angles. This can all be done on the new design without removing the friction ring and its holder from the instrument. This has a great advantage over the older design which was limited in its capacity.

As can be seen in the photograph (Figure 1) a carriage driven by a screw with knurled control forms the base for the graduated dial. The form for the friction ring (on which the cross-hairs are placed) is secured to this dial by means of a small machine screw. The dial is held in position by means of small clamps also secured by machine screws. Two floating pillars are placed on a line tangent

with the center of the entire assembly, the fit of these pillars is close enough so as to eliminate set screws. There are to the right of these pillars, two pins, adjustable in height (in the plane of the friction ring) which are secured by means of Allen set screws imbedded in the sides of the instrument. The small machine screw seen on the top of these two pins has beneath it two thin brass washers and two of celluloid of 1/32-inch thickness. Between these celluloid washers the cross-hair is secured without the danger of breakage through the pressure of the screw.

Two scales have been set in the instrument, one giving the measurement of the American inch to 64ths and one the metric to ¼ mm.

The dial assembly at the right of the instrument is the base of an old English compass, showing the form for the friction ring in place with an attached alignment setting. This dial is fastened to the carriage by means of small pins underneath, which fit into two sets of holes drilled into the carriage at right angles placing the dial at the exact center. For ordinary cross-hairs this dial can be lifted (carefully) from the carriage and placed in opposite coördinates or the form can be made to revolve through the desired degrees.

An added convenience is a magnifier with angular control for the verification of the settings.

Another feature which was placed on the instrument after the photograph was made was a set screw holding the shaft end of the driving screw stationary, after the desired setting had been obtained.

Reticules have been completed here of various types for several observatories one of which had seven hairs with six at right angles, made to match coördinate paper for the delineation of sun-spots. The new design allows greater ease of manipulation and is passed on hoping that it may prove useful to other amateurs.

NEAL J. HEINES.

560 Broadway, Paterson, New Jersey, August 18, 1939.

The Color of the Ash-grey Moonlight*

It is not a satisfactory characterization in an astronomic sense to call the reflection of the earth-light on the moon, which is to be seen before and after new moon beside the narrow crescent, "ash-grey moonlight." Usually it is described as "shimmering feeble grey-white light." Grey being a mixed color, according to the theory of colors, it is improbable that the mixing of colors takes place on the moon itself; the "ash-grey" moonlight rather appears grey only in contrast to the much brighter crescent. Observations of distinct colors in the earth-light on the moon have been exceedingly rare; Lambert on February 14, 1774, noted olive-green, and J. Schmidt in Athens on April 28, 1846, yellow.

What follows is an examination of the color of the "ash-grey" moonlight. It is, as we have already mentioned, the reflection on the moon of the light from the earth which is illuminated by the sun. The sun is a star of the spectral type G0, which means that the sunlight is of a yellow color. It is not probable that the sunlight, which is reflected from the earth on the moon, undergoes a change of color on the earth. As the moon shows exactly the spectrum of the sun, no change in color of the sunlight and of the earth-reflection takes place on the moon. The color therefore of the "ash-grey" moonlight must be the same as the color of the sun, that is, yellow.

I examined the color of the ashgrey moonlight with the help of color-filters

*Translated from the German by Dr. Richard Hertz, Carleton College, Northfield, Minnesota.

on the evenings of July 18, 19, and 20, 1939. For that purpose I chose from all color-filters of the firm of Schott & Gen., Jena, which are given in the lists 4777 and 5990 of that firm and which cover the whole visible spectrum, those filters which show, according to the list, the purest colors. I also took care that only those filters were employed which are highly transparent to colors and of little absorption. In the following tabulation the filters employed are listed, as well as their color specification according to the data of the firm; furthermore the degree, corrected for the thickness of the filter-glass, of transparency D for the light of a fixed wave-length which corresponds to the color of the filter. (D = 1.00, absolute transparency.) The loss of reflection of the two surfaces of the filters was not taken into account.

	λ	D
UG 3, bright violet glass	405μμ	0.72
BG 5, dark blue glass, without D for red	436	0.22
BG 12, blue glass, without D for red	436	0.72
BG 13, medium blue	436	0.87
BG 23, pure medium blue	436	0.88
VG 2, yellow-green glass	546	0.39
VG 6, bright bluish-green glass	509	0.64
VG 8, darker bluish-green glass	509	0.53
VG 9, yellow-green glass	525	0.47
GG 11, dark yellow for Contrastfilter	546	0.98
GG 14, dark yellow with very sharp blue-decrease	546	0.98
OG 2, pure orange	578	0.96
OG 3, reddish orange	600	0.90
RG 1, bright red	644	0.98
RG 2, pure red	644	0.94

The examination was carried out in such a way that these filters were introduced one after another into the beam of light of my 2-inch Merz refractor between objective and eyepiece. The visibility of the ashgrey moonlight was observed through each of these filters at a 24-fold magnification as to color, intensity, etc.

I found that the ashgrey moonlight, as compared with its appearance without filter, was clearly visible without essential diminution or change through the two yellow filters (GG 11 and GG 14); it was possible to recognize nearly all details through these filters. However, the observation through the green and orange filters showed a perceptible diminution of the ashgrey moonlight as compared with the yellow filters; this was even more marked so far as the violet and blue filters are concerned; through the red filters the light was hardly visible at all.

The examination therefore has shown that the ashgrey moonlight has a yellow color, in accordance with the foregoing considerations.

Later I had the opportunity to observe the reflection with the naked eye while the bright crescent itself was hidden by houses, and I could note the yellow color of the "ashgrey" moonlight without difficulty.

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Astronomy and the Mind of Man*

Psychiatry is that branch of medicine that has to do with mental disease. Although a relatively new study as a major regular part of the curricula of medical schools, it is interesting to note that mental ills rank among the oldest of known

*Read at the Regular Meeting of the New Haven Amateur Astronomical Society, October 8, 1938.

medical entities. It may be well said that it has really been within our own time or at least a short space from it that we have come to have an appreciation and an understanding of this field for, prior to this, psychiatry was practised only in asylums. Psychiatry as it may be thought of today, no longer limits itself solely to the traditional asylum diseases—rather, it has become the medical study and medical treatment of every aspect of human frailty ranging from the simplest of defects and difficulties of adaptation, to those more serious ones which may require institutional care.

In an attempt to trace the historical origins of psychiatry, how like or parallel is the course of the science of astronomy which also had to emerge through clouds of superstition and misbelief, to become today one of the sciences to which the world is looking for the key which will open for us the "ultimate vast." For as the heavens spread over the ancients and were watched by them so was mental disease known with the dawn of the earliest civilizations.

In the oldest empires known to us, Sumerai, Accadia, Babylonia, and Assyria, sickness was regarded as the work of demons, demons that swarmed in the air, in the earth, even in the waters. Relatively few descriptions of mental diseases appear in the sparse records of these peoples of 5000 B.C., yet sufficient has been unearthed to reveal that psychopathic disturbances not only took place but also that they exhibited essentially the same phenomena as occur in modern times. So too, with astronomy, these ancients knew of many of the same phenomena which we are privileged to view today.

I would digress for a moment in discussion of some of the earlier concepts of mental disease, some of which still affect attitudes, ideas or beliefs of present days.

Our chief knowledge of Egyptian medicine is derived from the Ebers Papyrus, which was written about 1550 B.C. It contains some very remarkable passages relating to diagnosis and it emphasizes the supposed supernatural origin of disease. It is in this passage really that we find our first real acquaintance with mental disease. In it, the action of evil spirits in causing madness is mentioned and a number of the different types of mental diseases described.

The first figure in authentic history to present clear and unmistakable signs of mental disease was Saul, King of Israel, who lived from 1097 to 1058 B.C. He became mad because he disobeyed divine injunctions, "wherefore, the Spirit of the Lord departed from Saul and an evil spirit from the Lord troubled him." According to the Scriptures, he suffered with recurrent attacks of melancholia, alternating with periods of excitement during which he exhibited homocidal tendencies. He finally committed suicide by falling upon his own sword.

Here we find the beginnings of a relationship of mental disease and sin, or rather of mental disease in its association with Christianity. Here is perhaps the first reference to the idea of disobeying divine injunctions or the will of the Lord and thereby being brought to a state of mental suffering; an idea which persists in the minds of many people even today. Way back in Chaldean times there was a belief that the celestial bodies were gods, a thing that transformed astronomy into religion.

Another great figure in history to present symptoms of mental illness was Nebuchadnezzar, whose reign stands out as one of the most illustrious in the history of Babylonia. He was insane for seven years. We read that "he was driven from men, and did eat grass as oxen, and his body was wet with the dew of heaven, till his hairs were grown like eagles' feathers, and his nails like birds' claws." His sickness assumed that form which in almost every age has been regarded as a frightful delusion, the belief of being transformed into an animal.

The early Greek, before the advent of the great Hippocrates believed that the various malevolent spirits and infernal deities who inhabited the earth and sky and the nether regions were capable of inflicting the different psychoses upon anyone they might select. The mythology of these people is filled with such references.

During this period the practice of medicine was entirely in the hands of priests or priest-physicians, who claimed to be able to interpret the will of the unseen gods and goddesses. As a result of this, the superstitious masses believed them to be the possessors of the most potent charm and therapeutic measures. Among other things in vogue was the practice of making the body as unpleasant as possible for the visiting spirits. This was done by squeezing, beating, starving, or fumigating the person in the hope of driving the spirit from him. Of further interest to us in this connection is that in using drugs, concoctions of herbs, etc., these great priests used a botanical knowledge associated with astronomical changes. We find frequent references in the compounding of prescriptions such as the following.

Mandrake in a draught of warm water was prescribed for witlessness and periwinkle for demoniacal possession but this wort—"shall be picked when the moon is nine nights old and eleven nights and thirteen nights and thirty nights and when it is one night old."

A second era in the history of psychiatry might be called the Grecian Era, a period from 600 to 146 B.C. ending with the destruction of Corinth. Here we find Pythagoras, Empedocles, and the great Hippocrates born into a world of active speculation where philosophy and medicine were inextricably entangled. Hippocrates traced his ancestry back to Aesculapius himself. He lived in the golden age of Pericles and contemporary with the most brilliant group of men known to history and he alone did much to emancipate the art of healing from earlier superstitions and make it a scientific study.

Here was a civilization which "dared to question" and which with the mechanical aids available certainly went far in laying a solid foundation for many present day sciences.

With the destruction of Corinth, Hellenic medicine and culture migrated to Rome and for a period there with Asclepiades, Celsus, Aretaeus, Galen, as well as the great orator Marcus Tullius Cicero, who incidentally brought into being the idea of conservatorship for mental cases, there was an advancing culture and knowledge of medicine and other sciences.

With the overthrowing of the Roman Empire 476 A.D. by the German tribes there began a period of disorganization and the great Epoch of Retrogression known as the Dark Ages from 476 to the beginning of the eleventh century. It is in this era that ideas of the supernatural reached their height where superstition and religion were linked together to retard the development of all scientific endeavor. Physicians were not only humiliated but put to death. Copernicus, as you know, feared arrest and did not immediately publish his statements of astronomical research.

As a result of the influence of the Church, supernatural aid came to be more and more esteemed, especially since the practice of medicine was so powerless in the face of the great epidemic diseases then prevailing. It was accepted as gospel that vampires, succubi, incubi, and myriads of unseen creatures populated the earth and tended to ravage man. Very trifling incidents were ascribed to the intervention of spirits and man was no longer master of himself. A quotation from a class, the Malleus, "There are two reasons why devils molest man at certain phases of the moon. First, that they may bring disrepute on a creature of God, namely the Moon

—and Secondly because they cannot, as has been said above, operate except through the medium of the natural powers. Therefore, they study the aptitudes of bodies for receiving an impression; and because, as Aristotle says, the brain is the most humid of all parts of the body, therefore it chiefly is subject to the operation of the moon which itself has power to incite humours. Moreover the animal forces are perfected in the brain and therefore the devils distort a man's fancy according to certain phases of the moon, when the brain is ripe for such influences."

The Chaldeans had knowledge of the periodic reappearance of the constellations and since this tended to determine the seasons, which in turn tended to govern organic life, a pernicious belief in the influence of the stars took place, which crippled the advance of astronomy even up to the time of Galileo. Chaldean astrology spreading westward increased rather than diminished the interest in the stars, not only the connection of the planets with natural phenomena and the reckoning of time but the mystical element involving prophecy of future events.

Even into the next century the period of Feudalism with the church combining its forces with the state all attempts at experimental science were suppressed. Men no longer cared to think for themselves. The Church encouraged servility and exact acceptance of its doctrines. To believe blindly, without question, was proper, while to seek knowledge was a crime that the medieval church and her powerful governmental allies stood ever ready to punish.

Even going into the Renaissance psychiatry was particularly backward and the mystics and astrologers were in ascendency. Alchemy was beginning to play a role in the life of people and the insane were treated by purging and bloodletting, the proper time for such measures being decided primarily by the conjunction of the planets and the phases of the moon.

As one reads of some of the ideas about mental sickness which held sway in these earlier times he is shocked into a real reflectiveness over the ideas and the suffering which prevailed. It is only when one keeps in mind the whole sociological picture that existed that a proper understanding takes place.

Man has always been afraid of the unknown. The quest for certainty, for security, and the clinging to what little security we do have is one of the powerful influences motivating our whole lives. The heavens—the universe was the great unknown. In the world, the sun came and the sun set. What assurance was there of its return? The night was dark. The moon was not faithful in its fullness and radiance. The stars gave only a wan glimmer without warmth. How natural, then, for primitive man, beginning to think, to attach his emotions to these phenomena; to watch the heavens, to feel their portent and to seek omens that might have bearing on himself. The very mightiness of the universe is awe-inspiring in its scope.

The second consideration is the intricate complexities of the mind of man. This too is wonderful to contemplate. One might almost say the mind of man has grown with increased knowledge of the universe. It has taken on perspective and third dimension.

But this mind of man when it is in the throes of a mental or emotional turmoil is a mighty thing to behold. Of more specific interest to us, however, is the very content or the mental disease, itself. Strange things take place within man's mind. Stranger things take place within that same mind when it becomes a prey of infection or other biochemical change. It is of some of these changes particularly as they show an astronomical relationship that I would speak.

In the process of our adjustment to life, certain things are essential. First, we

have to have ways of knowing what our environment is, then to be enabled to understand its meaning and how to feel about it and react or behave in regard to it.

Anything that is altered or disordered in any one of these realms of mental activity cannot help but affect behavior of the person. If we do not perceive correctly or if because of some disorder of our perception field, we show differences in sense impressions, it naturally follows that our reasoning and judgment are changed and likewise our behavior.

Some years ago I watched a person in a hospital as he stood before a window, hours on end speaking only when the sun spoke to him and telling him what he should do. Then I recall being called in an emergency in the middle of the night and listened at length as a woman alternately pleaded to be held down then raged to get away to go out and up to the moon. Frequently she answered back to "the voice" from our lady Luna, sometimes agitatedly pleading—"No, not that." Then again, "Wait and I'll come."

These voices—actual sense percepts of hearing—sounds actually heard by these patients although they came from no auditory stimulus of the environment—are things which in our language we call "hallucination."

Then there is still another level of psychic integration, the associative levels, which pick up the sensory percepts, associate and correlate them so that reasoning takes place and a judgment is formulated. One of the major afflictions of this field is the dread thing which we call delusion. Delusion is a false belief, highly improbable, often manifestly impossible, an idea which cannot be corrected by an appeal to the person's reason and also one that is out of harmony with the individual's past experience and education.

It is a dread thing, and the cause is so unknown. It has its roots in the very foundations of the personality. There is an isolating aspect to this symptom which is mighty to conceive. It is like a huge spiral nebula or a dark vast expanse of space. It is an idea so apart from anything within the person's environment that it could well be said that delusion is conceived in loneliness. Here, too, we find an astronomical motive, manifest with such frequency that it is far beyond a matter which mere chance or coincidence might develop.

Delusions are of all kinds. They sometimes are of a nature so grandiose as to be almost incomprehensible. They are often of a nature so self abasing that they would make any known state of servitude seem actually to be a real freedom. When delusion takes on astronomical trend it is accompanied by almost any of the various emotions which we have.

I recall a man who claimed he moved the clouds and made the rain. It wasn't his delusion that made him hard to handle. It was his arrogance. Arrogance in keeping with his grandiose idea. The sun—the stars, the planets—all play a part in the delusions of men. The great Jung delivering the Terry lectures for Yale a year ago cited a case of a man who in the hospital stood at the window holding his arms aloft and sighting with his eyes and swaying his body, and claimed to be moving the sun, thereby acquiring a kind of power and grace. Years later when Jung was in Paris he had opportunity to study some recently translated documents dating back to civilizations before Christ. In these documents there was an account of a seeress who in instructing pupils in acquiring power and grace advised them to look to the sun and through use of certain gesture, similar to the patient of Jung's earlier experience, thereby acquire these characteristics. Jung used this to show the possibility of a basic unconsciousness as a factor in the mind of all men.

Naturally today, much of the delusional content of many people has in it an

astrological coloring for the content of delusion keeps pace with the advancing civilization and now includes radio, television, and other new inventions or popular fads of the time.

Just recently I saw a man who talked at length about other people not only reading his thoughts and making him think things but doing it through the aid of the position and influence of the sun and the moon. The sunset drew thoughts out of him. The sunrise helped to put things in his mind. Much of his ideational trend in respect to planets and constellations was, however, complicated by a great deal of astrological idea. Still another case is that of a woman in almost constant state of excitement at times showing great apprehension and a behavior frenzied to the extreme. Then after a period a change to more elated mood, with different kind of activity, dancing, relieved and chanting—"The moon is on the wane."

There is another part of the realm of intellectual association which, when affected, colors the behavior of man. This is the thing we call phobia—state of fear. The phobias of man very frequently take on astronomical significance. Fear of the dark, fear of the night has been almost a part of man's basic consciousness. His greater difficulty in functioning with the equipment with which he is endowed brings a greater state of insecurity. Fear of the dark is one of the most common afflictions of childhood and in it are associated ideas of sin and punishment. Man through the ages has shown fear of the night and has associated with the night and the heavens, dire calamities ever ready to descend on him. Even today this holds true. Old cuts show persons fleeing covering their heads and kneeling or lying in frenzied supplication while meteor showers course through the earth's atmosphere.

You recall but a few years ago the Easter eve when the moon dogs and the brilliant lunar halo held sway over New Haven. The following day newspaper accounts gave stories of its effect on people and included the fact that many went to their homes to pray.

Then in the field of volition, those odd impulsive and compulsive acts of people, here too astronomical influence is frequent. Some of these bits of stereotyped behavior are the result of ingrained superstition. Others are the effect of a more deep-seated personaltiy trouble.

Here, again, the influence of the moon is the most commonly in evidence. I recall a man brought to a hospital because his compulsion necessitated his running out into the night at the full moon and gesticulating and salaaming with his arms over a fixed period of time. If his activity was interfered with, his agitation and suffering were very great. He would fight with his compulsion usually ending by succumbing to its influence.

I have known adults who in an unguarded moment accidentally viewed the moon over their left shoulder. Reacting to superstition they have felt the need of repeating some peculiar phraseology or resorting to some form of motor activity to do away with any bad influence which might function. In talking to some of these, one finds that they know, intellectually, of the silliness of their behavior yet emotionally feel a strange stirring and unrest. Often they will endeavor to describe what amounts to a wonder or awe at the night which in certain moments of contemplation does actually become a source of worry to them. Some actually express a belief that there must be some possibility of being influenced and therefore it is best that they continue to use their stereotyped response and not take chances.

The sun and the moon have often been held responsible for the impulsive and compulsive acts of man.

It is very interesting in this connection to learn how the heavens were supposed to play a part in the question of the handedness of man. Why are most of us presumably right-handed?

This is a thing which, with our knowledge of brain function today, most acceptable theory points to a matter of cerebral dominance. One hemisphere has a dominance over the other and therefore initiates an activity. A certain characteristic of the left hemisphere of the brain giving it the power of pace maker, therefore stimulating right sidedness in us. (This is due to the fact that all brain fibers cross to the opposite side of the body before going to the part they serve.)

An earlier idea both Chaldean and Hebraic as to cause of handedness was that in looking to the east and following the sun across the sky there was influence from the sky more directly on the right side of the body thereby giving that hand greater potency. Of course, such a theory did not account for the left handed ones in their midst nor did it consider peoples living south of the equator who would have the reverse conditions of influence.

It is the emotional field of man, however, in which one finds today a tremendous source of his distress. Elation, depression, anxiety, indifference, irritability, expressions such as these when marked or prolonged cause a marked unadjustment of the person. Most common here will be expression of the effect of the elements on the person. Inclement weather becomes a source of irritability or depression. Anxieties are stimulated by the approaching storm and often the added frustration and expense either of money or effort, the result of bad seasons, build a fear which within one increases his whole tenseness of being. I have known some persons who express a sense of depression which is definitely associated in them with the full moon. I have known others who realized and even became somewhat apprehensive over the fact that with the full moon a strange unexplainable state of elation swept over them. Poets describe these states in better words in all these phases. Such things are important though because of the effect of one's emotions on his everyday behavior.

Above all these considerations is the fact that the very instinctive life of man is and has been influenced by our universe.

Historians tell us that aside from the war leaders and the physician-priests of earlier times the general masses of people did not think. They lived from day to day. The world was really influenced by a relatively few. This is undoubtedly true, excepting that in the masses, living from day to day, binding themselves together, following a leader, they were reacting to an instinctive thing within, a fear perhaps, a self preservation, a desire for security.

Studies of very primitive peoples show behavior and customs built around and associated with the changes in natural phenomena around them.

Peoples who have been untouched by Christianity have been found to have seasonal feasts in a sense similar to our own. There is rejoicing in the spring, celebration with the harvest and supplication with the coming dark of winter.

In part these things are determined by the nature of our universe.

This really is a theme all of its own, but it is obvious that our very desire for self-preservation is naturally going to be concerned with the world about us. So, too, our own self-preservativeness cannot help but realize its importance against the mighty heavens. So with all our instincts, the whole natural environment becomes a matter of deep concern. Lack of knowledge has brought us uncertainty and this leads to superstition and false belief. It leads to restraint in the ease of our own self expression. With our increased knowledge of astronomy we have

helped to ease the life of man. Man's mind has helped him to an adjustment of greater peace of life as a result.

Like the field of astronomy, the field of neurology and psychiatry has broadened its knowledge of how a few mechanisms operate. Such learning helps us to get along. The brain and the mind must deal with not only the microscopic cell, but with the atom and electron. In astronomy we must deal with light years and figures that seem almost incomprehensible. It may well be said then that when the scope of our knowledge spans that gap between the ultimate minutiae and the ultimate vast, or in simple terms the ultimate structure of the atom and farthest structures of the sky, then the mind of man may have greater opportunity to be at peace.

EVERETT S. RADEMACHER, M. D.

General Notes

Dr. Henry Norris Russell, director of the observatory at Princeton University, was elected to honorary membership in the New York Academy of Sciences at the recent annual meeting. (*Science,* December 22, 1939)

Dr. Wallace J. Eckert, of the department of Astronomy at Columbia University, has been appointed Director of the Nautical Almanac at Washington. He will assume his new duties in February. Dr. Eckert's principal work has been the highly successful adaptation of the Hollerith Punched-Cards machines to astronomical problems, notably to the calculation of standard coördinates for the Yale Zone work, and to a complete verification of Brown's Lunar Theory.

The Warner & Swasey Company is undertaking to build a Schmidt telescope. The size of the correcting plate is to be 24 inches, the mirror is 36 inches, and the focal ratio is 3.5. When glass is available it is hoped to have an objective prism in connection with this instrument. The mounting is to be of the cross-axis type, much like the new Lick astrographic.

The Rittenhouse Astronomical Society of Philadelphia held its regular monthly meeting on Friday, January 12, 1940, in the Hall of The Franklin Institute. The retiring president of the Society, Mr. Henry E. Hathaway, gave an illustrated talk on the topic, "Spots on the Planet Earth."

Cosmopolitan Calendar.—The question of the reform of the calendar is a live one in the minds of many people. The "Thirteen-month Calendar" and the "World Calendar" have been quite fully discussed and are understood by practically all intelligent people. Each has its adherents who see serious defects in the other. Mr. John W. MacIntosh of San Diego, California, has suggested a "Cosmopolitan Calendar" which, in his opinion, combines the favorable features of the other two. The outstanding feature of this third plan is to keep the quarters of the same length and to keep the months and weeks in step. This is done by assigning to the first month of each quarter five full weeks, thirty-five days, and to each of the other months four weeks, twenty-eight days. To some persons the large difference in the lengths of the months would doubtless be a fatal weakness. The author attempts to minimize this objection by insisting that the week and not the month is

the essential and fundamental unit in this calendar, and that adjustments in months must be made accordingly. It is just such adjustments which most persons are unwilling to make. However, a study of our present calendar will convince anyone of the desirability of a change of some sort.

Summary of Sun-Spot Observations at Mount Holyoke College, 1939

Month	No. of Obs.	North of Equator No. of Groups	North of Equator Av. Lat.	South of Equator No. of Groups	South of Equator Av. Lat.	Av. No. Groups at one Obs.	New Groups
January	11	14	+15°.5	18	−14°.2	6.91	32
February	15	13	15.8	17	13.1	6.13	25
March	17	13	17.3	18	12.4	5.29	25
April	13	19	14.2	16	11.7	8.23	35
May	21	24	15.3	23	12.7	8.81	41
June	12	16	13.5	14	13.6	8.08	23
September	8	8	14.7	7	11.4	6.50	16
October	19	13	14.8	12	11.1	5.74	20
November	23	9	16.2	15	9.0	5.26	21
December	10	4	17.4	12	11.0	4.80	13
Totals	149	133		152			251

Average number of groups at one observation 6.56
Average latitude of spots north of equator +15°.0
Average latitude of spots south of equator −12.2

The figures are consistent with a gradual decline in activity since the summary for 1938. The percentage decrease of groups in the northern hemisphere is three times as great as in the southern. One group in September was recorded as in latitude 0°. Even in this second year of the declining cycle, the average number of groups at one observation and the total of new groups remain higher than at any of the maxima (1905, 1917, 1928) recorded earlier in the present series.

The observations were made largely by Miss Edith Jones and Miss Barbara Bilsborough.

ALICE H. FARNSWORTH.

John Payson Williston Observatory, January 16, 1940.

The Nation's First Census of Housing

[Although this item is entirely non-astronomical in character, we are, nevertheless, gladly giving space to it in compliance with the special request that the information it contains be given the widest publicity possible. ED.]

A comprehensive picture of housing and home ownership in the United States will be compiled from information to be gathered by the 120,000 Census enumerators in conjunction with the Sixteenth Decennial Census to be conducted by the U. S. Bureau of the Census in April. Data—in response to a schedule of thirty-one questions bearing on the type of structure, equipment, and ownership—will be obtained for each of the approximately 35,000,000 dwellings throughout the country.

Housing experts point out that the information gathered will be of inestimable value in the determination of future housing policies. It will be of especial interest to manufacturers, builders, distributors, and bankers in their study of trends in home ownership and building in the United States. Census authorities explain that through their tabulations it will be possible to determine facts of vital importance to local geographical and political subdivisions. For example, cities will be able to determine the distribution of the various types of housing within their

limits, together with the possible need of expansion of transportation and communication systems, police and fire protection, schools, and similar facilities.

The tables will also help social workers to establish relationships between certain types of housing and human needs by correlating their own data on characteristics and locations of clients with the census information on characteristics of the homes.

Data showing the equipment in homes, together with the state of repair of the homes, will be of value to manufacturers and distributors of housing products in the planning of their sales campaigns.

Home finance institutions will find the average amount of mortgage and the data on mortgages of value in proving and checking the soundness of their investments and the possibility of mortgage expansion.

The aid of trade associations, financial groups and research organizations was obtained by Census officials in the preparation of the questions. In this manner the authorities feel they have arrived at a group of questions which will gather the greatest possible amount of useful information.

The Housing Census will be made at the same time as the balance of the Decennial Census and will be made by the same workers. Authority for the housing census was voted by Congress at its last session. Action on the appropriation has been deferred until the 1940 session.

The thirty-one questions to be asked by the enumerators in connection with the housing phase of the census have been tentatively grouped under the following headings:

1. Characteristics of structure in which dwelling unit is located.
2. Characteristics of dwelling unit.
3. Characteristics of occupied dwelling unit.
4. Mortgage characteristics of owner-occupied nonfarm 1 to 4 family structure.

Book Reviews

Preparation of Mirrors for Astronomical Telescopes, by George McHardie. (Blackie and Son, Limited, London. Price, 3s. 6d. net.)

In this small-sized, 86 page monograph, Mr. McHardie presents a well-organized outline of the considerations and processes involved in the making of an astronomical mirror, from the choice of glass to the mounting of the finished telescope. It seems to the reviewer (who incidentally has never made a mirror) that Mr. McHardie's book would be ideal as an introduction to the subject, for one just bitten by the "bug" whose bite engenders in the victim a desire to construct an astronomical mirror. The book is much shorter than "Amateur Telescope Making," is less replete with detailed digressions on sub-topics, and should, therefore, prove less confusing to a newcomer in the field. This is not intended to minimize in any way the merits of "Amateur Telescope Making," whose detailed digressions may enable the beginner to avoid the necessity of spending countless hours in the inefficient process of learning through making mistakes.

The book before us contains chapters on *Glass and Polishing Materials, Tools and Materials, Grinding, Polishing, Foucault's Shadow Test, Preliminary Testing, Parabolizing or Figuring, Measuring the Paraboloid, Silvering,* and *Star Testing,* as well as one consisting of *Notes on the Mounting of Small Reflectors.*

One wonders why authors on mirror-making do not lay more stress on the surfacing of the mirrors with aluminum, rather than silver. Practically all the large reflecting mirrors at research observatories are now aluminized, and there are a number of firms (at least in the United States) who will aluminize a small mirror such as an amateur's 6 or 8-inch, for a very reasonable consideration.

Carleton College, Northfield, Minnesota. R.S.Z.

Manual for Observational and Practical Laboratory Work in Elementary Astronomy, by Oscar Lee Dustheimer. (Edwards Brothers, Inc., Ann Arbor, Michigan.)

Teachers of astronomy oftentimes find it convenient to prepare laboratory manuals giving instructions for observational and practical work, usually with a view to the particular equipment that is available for their students. The manual by Oscar Lee Dustheimer is based on twenty years of such work at Baldwin-Wallace College, Berea, and is intended to serve, not only his own students, but also other groups in need of such a guide. The manual contains a wealth of suggestions, in the form of 112 exercises, a part of which are suitable for indoor work. The usefulness of the manual is further enhanced by the inclusion of a well-prepared set of star charts, with brief descriptions of each constellation; a list of 320 celestial objects suitable for telescopic study, with the right ascension and declination of each; and two bibliographies, pertaining, respectively, to works on general astronomy, and to special phases of astronomy. R.S.Z.

Carleton College, Northfield, Minnesota.

Seeing the Universe.—In these modern days when libraries no longer consist merely of books but include also microfilms and photoprints, it is, doubtless, quite proper to include in the section of "Book Reviews" a review of a film of astronomical subjects. The above is the title of such a film, or rather of five films, arranged and executed by Mr. Ruroy Sibley. The five films relate in order to subjects as follows: The Sun, The Moon, The Minor Planets, The Major Planets, The Milky Way and Exterior Galaxies. The five reels, with the explanatory manuscript which accompanies them, can be presented in approximately one hour by anyone who has a 16 mm. projector. We had the privilege of using the films in a program in Carleton College recently and can recommend them very highly to anyone wishing to provide an hour of instructive entertainment. Many persons in recent years have secured a much clearer impression than they had before, concerning the movements of the heavenly bodies, through the various planetarium demonstrations. The moving picture medium is another device for the same purpose. The films under consideration very ingeniously portray such phenomena as a total solar eclipse, the rapid rise of gases from the surface of the sun, forming the prominences, flying above the lunar surface, the change in phase of the planet Venus, the movement of an asteroid among the stars, the changing appearance of a comet's tail, and others. One may see at a glance a situation in the sky which would otherwise require many words of explanation and elucidation. The author of the film and of the descriptive lecture to be read in connection with the showing of the silent film is to be highly commended upon the successful manner in which he has accomplished his purpose.

Mr. Ruroy Sibley's address is 39 High Street, Croton-on-Hudson, New York.

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